Galácz, A. (ed.): 125th Anniversary of the Department of Palaeontology at Budapest University – A Jubilee Volume
Hantkeniana 6, 187—217, Budapest, 2008

Sarmatian foraminifera fauna from Budapest (Hungary)

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Abstract

Well-preserved Lower Sarmatian (Elphidium reginum Zone) foraminifera fauna from an open working pit at Ludovika square, four boreholes and a ventilation tube of the subway (line #3) in Budapest were studied. Detailed systematic descriptions and paleoecological interpretation (together with the ostracod fauna) of 28 taxa are provided. Three biofacies (with *Elphidium*, with *Cibicides*, with *Articulina* and *Nodophthalmidium*) could be distinguished. These different foraminiferal biofacies and ostracod faunas show the changes of an epiphytic community that was influenced by the phytal substrates, the water depth, the nutrient and oxygen content and the salinity. The changes in the abundance of foraminifers and ostracods indicate distinct changes in the vegetation (algae to seagrasses) reflecting decrease of the water-depth and salinity during the Early Sarmatian in this region of the Central Paratethys. The studied foraminifera fauna is most similar to the foraminifera assemblage from the Zsámbék Basin (Hungary) and to the assemblages of the Eastern Paratethys due to the lack of buliminids in the other region of the Central Paratethys.

Introduction

In the courtyard of the Hungarian Natural History Museum (Budapest) a more than 10 m deep working pit was dug out due to the reconstruction of the former building of the Faculty of Science (Eötvös Loránd University) (Fig. 1). This temporary outcrop gave an opportunity to study the microfauna from the exposed Sarmatian (upper Middle Miocene) beds. This material is completed with the microfauna of four boreholes and ventilation tube of the subway (line #3) that situated in the neighbourhood (Fig. 2).

The main aim of the present study is the taxonomical description of the foraminifera fauna because detailed analyses of Sarmatian foraminifers from Budapest has not been published yet. Only faunal lists were published by SCHAFARZIK, SCHMIDT and MAJZON (MAJZON, 1966). First comprehensive study of the Sarmatian foraminifers from Hungary were made by KORECZ-LAKY (1964, 1965, 1968, 1973, 1982). She recognized different biofacies in the Sarmatian deposits from the Mecsek and the Tokaj Mts based on the foraminifera fauna that we try also to identify in the studied material of Budapest. Recent lytaxonomical, stratigraphical and paleoecological studies of Sarmatian foraminifers from Hungary (Zsámbék Basin) were published by GÖRÖG (1992). Further goal of this work is the paleoecological interpretation of the microfauna (foraminifera and ostracods). The detailed systematic description of the ostracod fauna from these beds (TÓTH, 2004) add an ability to complete our knowledge about the paleoenvironment.

During the Sarmatian the Pannonian Basin was a subbasin of the Central Paratethys, where the studied area is located. This semi-enclosed basin is characterized by a very peculiar, lowly diversified fauna and the environmental reasons of its origin has been controversial yet. These new results from Budapest compared to those from other regions of the Paratethys can help to understand the environmental conditions in this subbasin of the Sarmatian Central Paratethys.

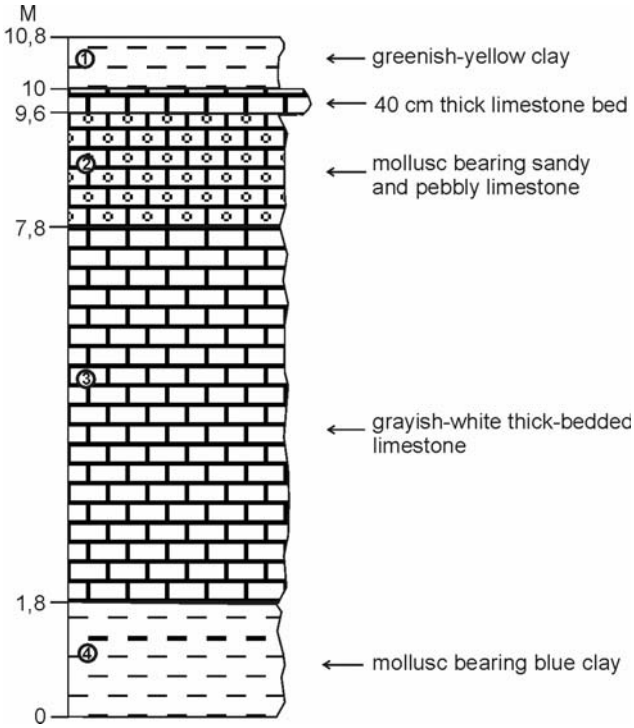

Fig. 1. Section of the open working pit at the Ludovika square (Budapest).

Material and methods

The studied samples were taken from four boreholes (#596, #598, #617 and #618), a working pit and a ventillation tube of the subway (line #3) at Ludovika square in Budapest (Fig. 2). The studied boreholes penetrated only Sarmatian deposits except borehole #596 that reached the Badenian strata (Fig. 3). The Sarmatian layers follow unconformably the Badenian rocks. Upper Sarmatian beds on the Lower Sarmatian also overlain an erosional surface (BUBICS, 1978). The general composition of the Sarmatian successions along the Üllői street – where the studied boreholes are located – is the following: mollusc-bearing clayey marls are dominant changing into calcareous marls, sandy limestone and sandstones upwards. Sandy intercalations occur between the layers. These layers are overlain by antropogenic filling. This series can be placed in the Kozárd Formation (HÁMOR, 1997).

Altogether sixty-nine samples were studied micropaleontologically. For each sample, about 100 g of air-dried sediment was soaked in a dilute solution of hydrogen peroxide to extract the microfauna for the taxonomical and paleoecological investigations. The paleoecological study of the assemblages based on the qualitative and quantitative analyses (the percentage distribution of different foraminiferal groups and ostracod taxa) (Fig. 4). The components of the different foraminiferal groups based on the morphology and ecological character of the given taxa are distinguished (Tab. 1). Because of the low diversity of the microfauna using of more complex statistical analyses was not necessary.

General characteristics and stratigraphical interpretation of the Sarmatian foraminifera fauna

Form the studied Sarmatian successions twenty-eight foraminifera taxa belonging to three order (Miliolida, Buliminida, Rotaliida), to twelve families (Hauerinidae, Tubinellidae, Bolivinidae, Buliminellidae, Fursenkoinidae, Caucasinidae, Glabratellidae, Cibicididae, Nonionidae, Rotaliidae, Calcarinidae, Elphidiidae) and fifteen genera could be determined (Tab. 2). Low diversity and great abundance of generally well-preserved specimens are characteristic of the studied fauna. However the miliolids are badly-preserved (mainly casts), fragmented, thus they are undeterminable in most cases. The studied successions can be ranged into the Elphidium reginum Zone (Early Sarmatian) based on the presence of the index fossil. However the specimens of *E. reginum* are absent in the lowermost Sarmatian beds as usual in the other Hungarian series (KORECZ-LAKY, 1968, 1973; GÖRÖG, 1992) (Tab. 2). In other regions of the Central Paratethys (Vienna Basin: GRILL, 1941; PAPP, 1974; RÖGL, 1998;

HARZHAUSER, PILLER, 2004; Carpathian Foredeep: LUCZKOWSKA, 1998; East-Slovakien Basin: JIŘIČEK, 1972; Transylvanian Basin: POPESCU, 1995, FILIPESCU, 2004). the Sarmatian series usually begin with the Anomalinoides dividens Acme Zone. This zone is missing from the studied sections as well as from the other Hungarian localities (Mecsek Mts, SW-Hungary, Tokaj Mts and Zsámbék Basin) (KORECZ-LAKY, 1964, 1968, 1973, 1982; GÖRÖG, 1992). To explain these phenomena needs future investigations.

The comparison of the studied Sarmatian foraminifera fauna from Budapest to the that from the other regions of the Central and Eastern Paratethys is not easy, due to the different amount of the available data. The studied assemblage shows the highest similarity (more than 90% of the taxa are common) to the foraminifera fauna in the Zsámbék Basin (Hungary) (GÖRÖG, 1992) (Tab. 3). It can be explained with the short geographical distance. Inside the Paratethys the studied fauna is mostly resembled to the assemblages of the Eastern Paratethys. The main difference in the faunal composition of the other localities in the Central Paratethys is that the buliminids are usually missing (Tab. 3).

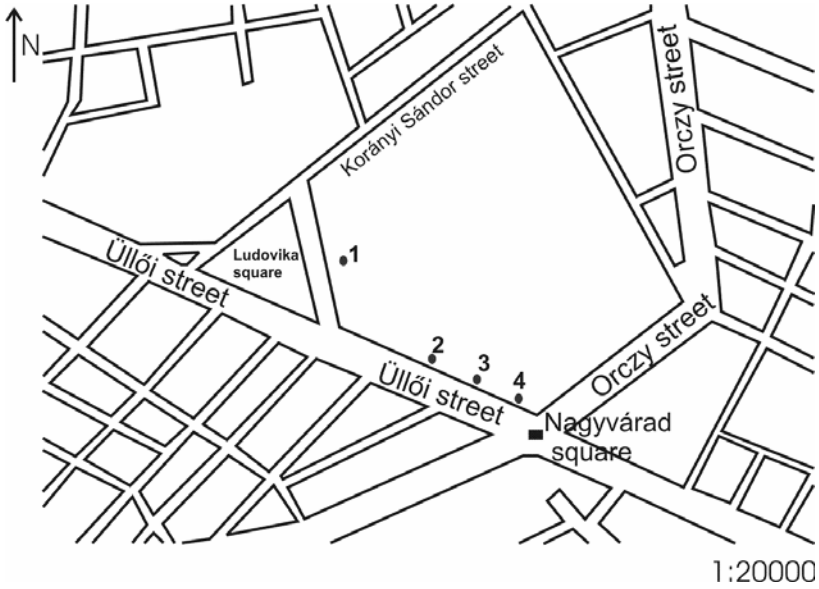

Fig. 2. Chart with locations of the studied boreholes, the working pit and the ventilation tube in Budapest – 1. ventilation tube, working pit and borehole #596; 2. borehole #617; 3. borehole #598; 4. borehole #618.

Paleoecological interpretation of the Sarmatian foraminifera and ostracod fauna

The general composition of the studied microfauna (foraminifers, ostracods) suggests the dominance of an epiphytic benthic community during the Lower Sarmatian (E. reginum Zone) in this region of the Central Paratethys. The lowermost Sarmatian beds (see borehole #596, 24.1-16.2 m in Fig. 4) are characterized by the predominance of keeled (including spinose) elphidiids. Infaunal non-keeled elphidiids, nonionids, buliminids (*Caucasina*) in low abundance are also present (Tab. 2). Among the keeled elphidiids two species (*Elphidium crispum* and *E. aculetaum*) live recently. The specimens of *E. crispum* are most frequently found on the rhizomes of seagrass *Posidonia* and on the shallow water green alga *Udotea*. The spinose *E. aculeatum* lives on arborescent algae. The presence of the spiral canal-system and the multiple apertural openings at the elphidiids with carinated and acute periphery indicates that they are epiphytic, suspension feeding forms (LANGER, 1993). Presumably the other keeled Sarmatian forms (i. e. *Elphidium fichtelianum*, *Elphidium macellum*) had the same microhabitat. Generally the epiphytic species diversity relates to the temporal availability, the life-span of substrate providing plants. Thus the studied medium-diverse epiphytic foraminifer assemblages indicate smaller algae microhabitat with relatively short life-span (LANGER, 1993). Thus the predominance of the keeled elphidiids suggests dense arborescent algal substrate during the earliest Sarmatian. In these beds the xestoleberids and the loxoconchids are dominant in the ostracod fauna (Fig. 4). For example *Loxoconcha japonica* and *L. matagordensis* recently lives on leaves of *Zostera* (eelgrass) (KAMIYA, 1988, CRONIN et al., 2005). The species of *Xestoleberis* usually are phytal ostracods that occur in littoral or sublittoral depths. The species with „Xestoleberis-spot" like *Xestoleberis fuscata* in the studied material indicates photic zone (HARTMANN, 1975; PURI et al., 1969). The dominance of these groups also confirms the

presence of the vegetation on the substrate in this region. The ostracod and foraminifer assemblages indicate shallow-marine, littoral (or brackish?) environment with rich algal vegetation in this subbasin of the Sarmatian Sea. The presence of the keeled elphidiids indicates temperate-warm water temperature in this time (MURRAY, 1991). The above-discussed biofacies with *Elphidium* are widespread in the Early Sarmatian in the other parts of Hungary. KORECZ-LAKY (1964, 1968, 1973) and GÖRÖG (1992) showed this biofacies from the Lower Sarmatian beds of the Mecsek Mts, the Tokaj Mts and from the Zsámbék Basin, respectively.

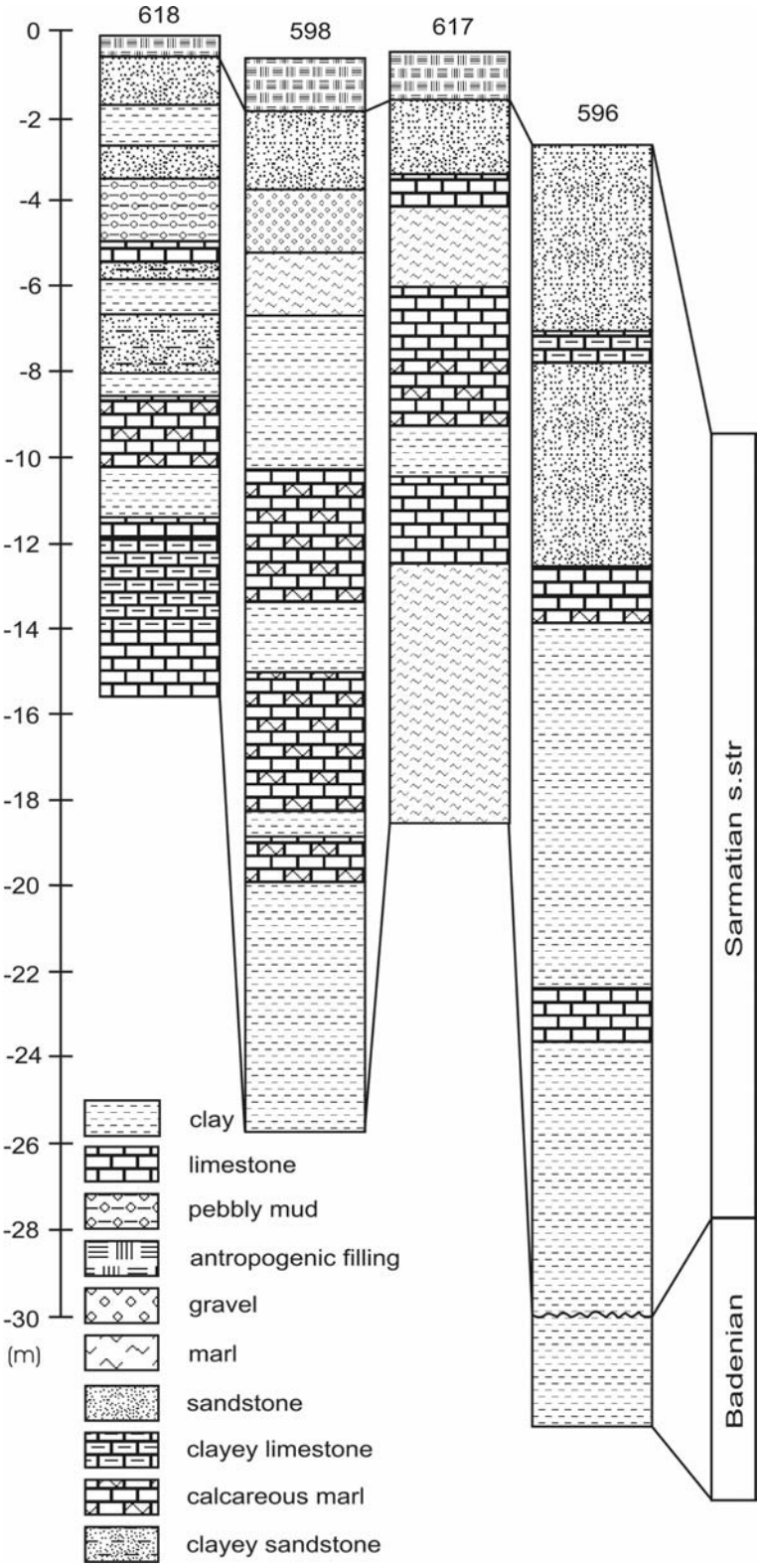

Fig. 3. Lithostratigraphical logs of the studied boreholes from Budapest (modified after ULLMANN 1973).

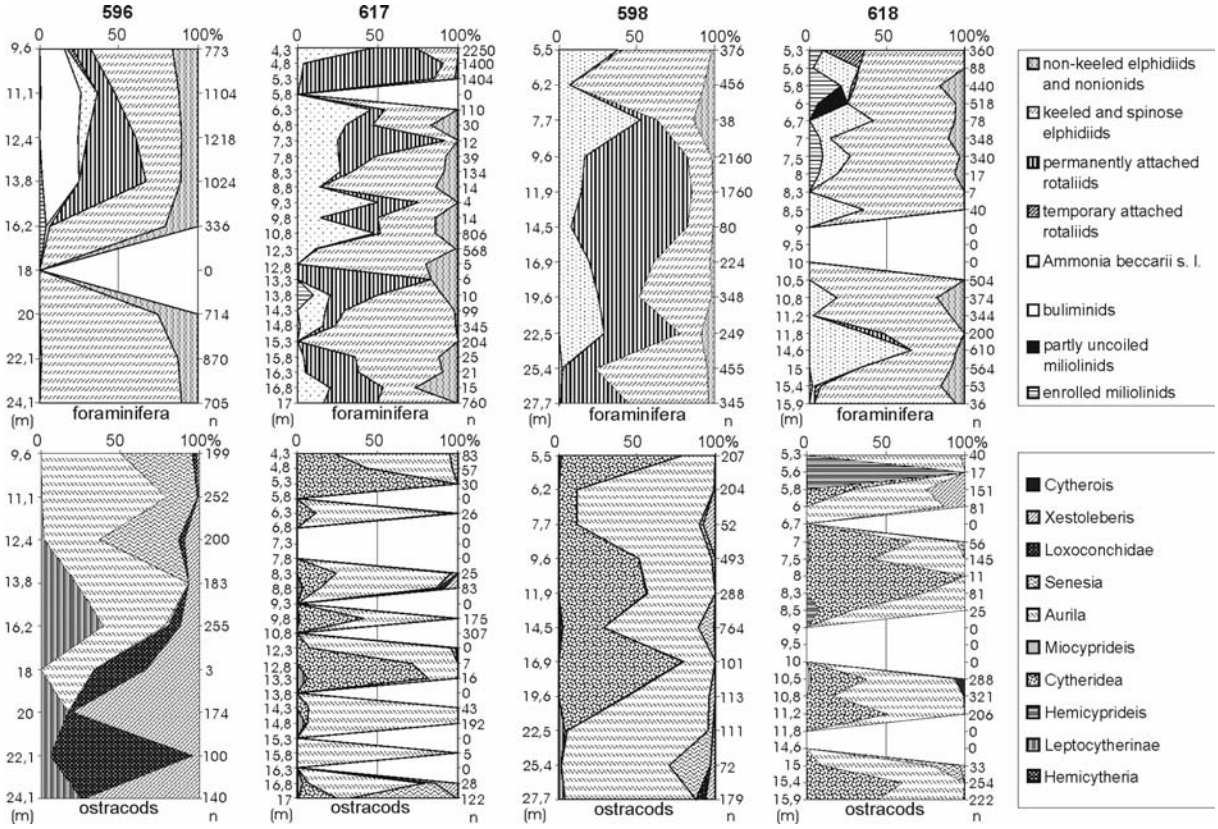

Fig. 4. Percentage distribution of foraminiferal and ostracod groups from different boreholes of Budapest (#596, #598, #617 and #618). n – the number of specimens in the given sample

In the upper part of the Sarmatian succession (in the boreholes #596, 16.2-9.6 m, #617 and #598 in Fig. 4) the diversity of the foraminifera fauna increases (Tab. 2). Mostly epiphytic, attached rotaliids (*Lobatula lobatula*, *Schackoinella* sp.) and the species *Ammonia beccarii* appeared in great abundance beside the keeled elphidiids. Some enrolled miliolinids also appeared in these beds. LANGER (1993) discussed the species *Lobatula lobatula* as permanently attached foraminifer that often lives on seagrass leaves or rhizomes. Probably the miliolinids also belong to this epiphytic community because numerous genera of miliolinids (i.e. *Triloculina*) are considered as permanently motile, grazing epiphytes (LANGER, 1993). The mixture of the different morphotypes of epiphytes and the high diversity of the community (permanently attached, motile suspension feeding foraminifera and permanently motile, grazing epiphytes) indicate plant microhabitats with annual or perennial life-spans. The ratio and the diversity of the infauna also increase (mainly directly above the biofacies with *Elphidium*) due to the appearance of bolivinids, and other buliminids (*Fursenkoina, Buliminella* beside the *Caucasina*). This could be connected with the phytal microhabitats with high detrital content that influence the occurrence and abundance of the epi- and infaunal elements (LANGER, 1993). The presence of species *Ammonia beccarii, Lobatula lobatula* and keeled elphidiids in these beds suggests warm-temperate shallow water (depth less than 50 m) (MURRAY, 1991, CHIERICI et al., 1962). In this environment appeared the index fossil, *E. reginum* possessing few long spines on the periphery. The reason of morphological adaptation can be explained with the transition of the algal into seagrass vegetation. This phenomenon can be detected also in the Zsámbék Basin (GÖRÖG, 1992). In these beds the large and strongly calcified *Aurila, Cytheridea* and *Senesia* are the most common ostracods (Fig. 4). The dominance of *Aurila* suggests also the phytal assemblage because there are numerous *Aurila* species that belong to the phytal ostracods (PURI et al., 1969). The abundance of *Cytheridea* indicates the sandy bottoms (HARTMANN, 1975). The studied ostracod fauna suggests epineritic, infralittoral to upper circalittoral zones with well-ventilated waters. This biofacies was described by KORECZ-LAKY (1964, 1968) from the Lower Sarmatian beds in the Mecsek Mts and from the Zsámbék Basin (GÖRÖG, 1992) as biofacies with *Cibicides* because previously the species *Lobatula lobatula* was ranged into the genus *Cibicides.*

In the uppermost part of the studied Sarmatian succession (see in borehole #618 (8.5-5.3 m) on Fig. 4) the diversity of the epiphytic microfauna decreases again (Tab. 2). The infaunal elements (bolivinids, buliminids) and the permanently sessile epiphytes (*Lobatula lobatula*) dissappeared. Beside the motile

keeled elphidiids the proportion of permanently motile enrolled miliolinids increases and the temporary motile *Rosalina* appeared in the series. This faunal composition indicates a distinct vegetation change, dominance of short life-span (2-5 months) plants (LANGER, 1993). The great number (more than 20%) of partly uncoiled miliolinids (i.e. *Articulina*) suggests near-shore settings because this form favours the very shallow and less agitated water with depths less than 30 m (LUCZKOWSKA, 1974). This coincides well with the ostracod fauna where the cyprideids (*Miocyprideis, Hemicyprideis*) appeared and became more frequent indicating the decrease of salinity (MORKHOVEN, 1963) (Fig. 4). This biofacies with uncoiled miliolinids mentioned as the biofacies with *Articulina* and *Nodophthalmidium* can be found in the Zsámbék Basin (GÖRÖG, 1992), in the Mecsek Mts and in the Tokaj Mts (KORECZ-LAKY, 1964, 1968, 1973).

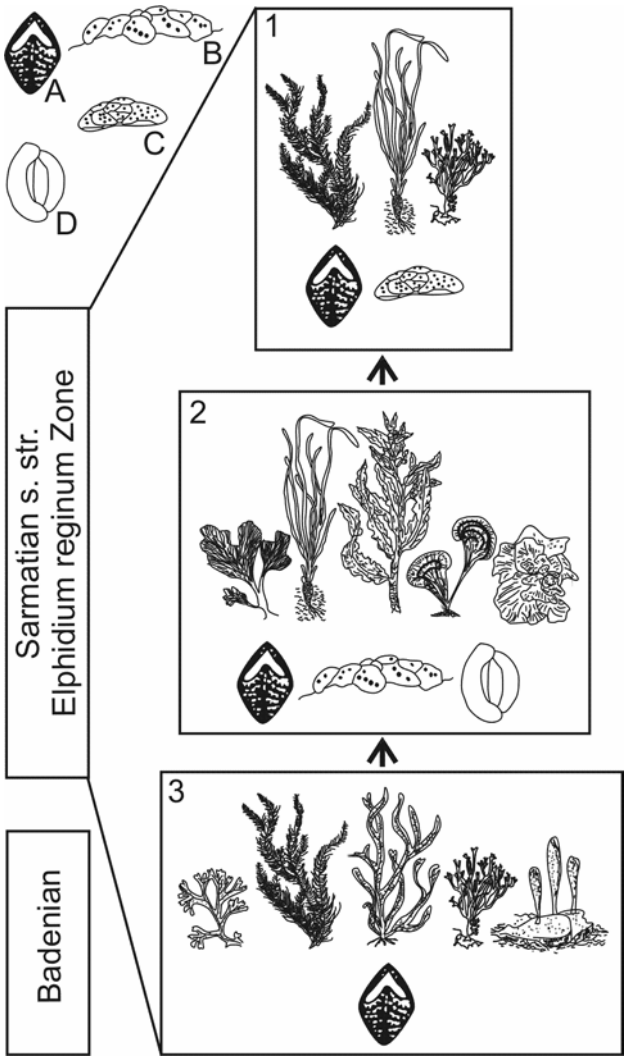

Fig. 5. Change of the vegetation and the the foraminiferal biofacies during the Early Sarmatian in this subbasin of Central Paratethys (in the region of Budapest) (modified after LANGER, 1993). 1 – biofacies with *Elphidium*, 2 – biofacies with *Cibicides*, 3 – biofacies with *Articulina* and *Nodophthalmidium.* A – suspension feeding keeled elphidiids, B – permanently attached rotaliids, C – temporary motile rotaliids, D – permanently motile grazing epiphytes.

Conclusions

Qualitative and quantitative analyses of the Sarmatian foraminifera fauna from four boreholes, an open working pit and a ventilation tube of the subway (line #3) in Budapest were made. The rich and generally well-preserved fauna are characterized by relatively low-diversity (twenty-eight taxa) but the taxa belong to numerous (twelve) families. On the basis of *Elphidium reginum* the age of the studied beds is Early Sarmatian (Elphidium reginum Zone).

Tab. 1. Distribution of the species in the different foraminiferal and ostracod groups.

Foraminiferal groups	Species of foraminifer	Ostracod groups	Species of ostracod
Non-keeled elphidiids	*Nonion bogdanowiczi* VOLOSHINOVA	*Xestoleberis*	*Xestoleberis fuscata* SCHNEIDER
and nonionids	*Nonion commune* (D'ORBIGNY)		
	Elphidiella aff. *serena* (VENGLINSKI)	Loxoconchidae	*Loxoconcha* ex gr. *punctatella* (REUSS)
	Cribroelphidium ex. gr. *granosum* (D'ORBIGNY)		*Loxocorniculum hastatum* (REUSS)
	Elphidium hauerinum (D'ORBIGNY)		*Loxocorniculum schmidi* (CERNAJSEK)
	Elphidium obtusum (D'ORBIGNY)		
		Senesia	*Senesia vadaszi* (ZALÁNYI)
Keeled and spinose	*Elphidium aculeatum* (D'ORBIGNY)		
elphidiids	*Elphidium crispum* (LINNÉ)	*Aurila*	*Aurila mehesi* (ZALÁNYI)
	Elphidium fichtelianum (D'ORBIGNY)		
	Elphidium macellum (FICHTEL et MOLL)	*Hemicytheria*	*Hemicytheria omphalodes* (REUSS)
	Elphidium reginum (D'ORBIGNY)		
	Elphidium aff. *pulvereum* TODD	*Miocyprideis*	*Cytheridea hungarica* ZALÁNYI
	Elphidium ex. gr. *puscharovski* SEROVA		
		Miocyprideis	*Miocyprideis sarmatica* (ZALÁNYI)
Temporary attached	*Rosalina* sp.		
rotaliids	*Schackoinella imperatoria* (D'ORBIGNY)	*Hemicyprideis*	*Hemicyprideis dacica dacica* (HÉJJAS)
Permanently attached rotaliids	*Lobatula lobatula* (WALKER et JACOB)	*Leptocytherinae*	*Amnicythere tenuis* (REUSS) *Callistocythere egregia* (MÉHES)
			Callistocythere maculata PIETRZENIUK
Enrolled miliolids	*Cycloforina contorta* (D'ORBIGNY)		*Callistocythere tokajensis* PIETRZENIUK
	Triloculina intermedia KARRER		
	Varidentella pseudocostata (VENGLINSKI)	*Cytherois*	*Cytherois sarmatica* (JIŘIČEK)
Partly uncoiled miliolids	*Nodobaculariella sulcata* (REUSS) *Articulina* sp. indet.		
Buliminids	*Bolivina antiqua* D'ORBIGNY		
	Bolivina moldavica DIDKOWSKI		
	Bolivina moravica CICHA et ZAPLETALOVA		
	Bolivina sarmatica DIDKOWSKI		
	Buliminella elegantissima (D'ORBIGNY)		
	Fursenkoina acuta (D'ORBIGNY)		
	Fursenkoina sarmatica (VENGLINSKI)		
	Caucasina schischkinskye (SAMOYLOVA)		
Ammonia beccarii s. l.			

In the studied series three biofacies could be distinguished (the biofacies with *Elphidium*, with *Cibicides* and with *Articulina* and *Nodophthalmidium* in succession). According to the studies of KORECZ-LAKY (1964, 1968, 1973) and GÖRÖG (1992) these biofacies also can be found in the other parts of Hungary. For the paleoecological interpretation the data of ostracods are also used (TÓTH, 2004). All studied Early Sarmatian assemblages belong to epiphytic community on the basis on the recent analogy (LANGER, 1993). The composition of the microfauna was influenced by the type of the phytal substrates, the nutrients, the water depth, the oxygen content and the salinity. In the lowermost Sarmatian the ostracod and foraminifera assemblages (biofacies with *Elphidium*) indicate shallow-marine, littoral (or brackish?) environment with rich arborescent algal vegetation characterized by relatively short life-span. Above there is a highly diversified epiphytic and infaunal foraminiferal assemblage (biofacies with *Cibicides*) indicating annual and perennial life-span plant microhabitats (sea-grasses and algae) with high detrital content. The studied ostracod fauna suggest sepineritic, infralittoral to upper circalittoral zones with well-ventilated waters In the uppermost Sarmatian (biofacies with *Articulina* and *Nodophthalmidium*) the microfauna suggests brackish near-shore settings (less than 30 m) with less agitated water and rich short life-span-vegetation. Summarizing, the microfauna and the vegetation changes suggest the decrease of the water-depth and the salinity. The studied foraminifera fauna compared to the other region of the Paratethys mostly resembles to the foraminifera assemblage in the Zsámbék Basin (Hungary) probably because of the short geographical distance. Both microfauna is very similar in general species composition, and all biofacies of Budapest are present in the Zsámbék Basin in the same order. In the lowermost Sarmatian beds of the Zsámbék Basin the biofacies with miliolids also occured (GÖRÖG, 1992). Another difference that in the biofacies with *Cibicides* of the Zsámbék Basin the buliminids are very

subordinate probably due to the lower quantity of the detrital content. In the biofacies with *Articulina* and *Nodophthalmidium* the ostracod fauna in Budapest shows a decrease in salinity which could not have been traced in the Zsámbék Basin. The fauna is more similar to the assemblages of the Eastern Paratethys because buliminids are missing from the other region of Central Paratethys.

Tab. 2. List of the identified foraminifer taxa from Budapest with their oxic preferences (KAIHO, 1991, 1999), modes of life (MURRAY, 1991) and absolute abundance in the different Sarmatian biofacies. (O – oxic, S – suboxic, E – epifauna, I – infauna).

Species of foraminifer	Biofacies with *Elphidium*	Biofacies with *Cibicides*	Biofacies with *Articulina* and *Nodophthalmidium*	Biofacies with *Elphidium* or *Cibicides*	Mode of life	Oxic preference
Nodobaculariella sp.			14		E	O
Cycloforina contorta (D'ORBIGNY)	7		8		E	O
Triloculina intermedia KARRER			10		E	O
Varidentella pseudocostata (VENGLINSKI)			10		E	O
Articulina sp. indet.		3	84		E	O
Miliolidea sp.		45	175		E	O
Bolivina antiqua D'ORBIGNY		19			I	D
Bolivina moldavica DIDKOWSKI		311			I	D
Bolivina moravica CICHA et ZAPLETALOVÁ		4			I	D
Bolivina sarmatica DIDKOWSKI		48			I	D
Buliminella elegantissima (D'ORBIGNY)		549			I	S
Fursenkoina acuta (D'ORBIGNY)		17			I	S
Fursenkoina sarmatica (VENGLINSKI)		4			I	S
Caucasina schischkinskye (SAMOYLOVA)	10	69			I	S
Rosalina obtusa D'ORBIGNY			106		E	O
Schackoinella imperatoria (D'ORBIGNY)		48		2	E	O
Lobatula lobatula (WALKER et JACOB)		8167		24	E	O
Nonion bogdanowiczi VOLOSHINOVA	48	159	10	66	I	S
Nonion commune (?) (D'ORBIGNY)	14	36			I	S
Ammonia beccarii (LINNÉ) s. l.	7	3378	169	742	I	?
Elphidiella aff. *serena* (VENGLINSKI)	14				I	?
Cribroelphidium ex. gr. *granosum* (D'ORBIGNY)	103	857	107	78	I	S
Elphidium aculeatum (D'ORBIGNY)	70	3291	435	180	E	O
Elphidium crispum (LINNÉ)	94	291	104		E	O
Elphidium fichtelianum (D'ORBIGNY)	252	202		14	E	O
Elphidium flexuosum reussi MARKS	10			3	E	O
Elphidium hauerinum (D'ORBIGNY)	178	265		2	I	?
Elphidium macellum (FICHTEL et MOLL)	1741	5788	750	1703	E	O
Elphidium obtusum (D'ORBIGNY)		21	24	42	I	?
Elphidium reginum (D'ORBIGNY)		372	125	200	E	O
Elphidium aff. *pulvereum* TODD		3			E	O
Elphidium ex. gr. *puscharovski* SEROVA		13			E	O

Tab. 3. Distribution of the identified foraminifer species in the other region of Paratethys. (1 – Zsámbék Basin, 2 – Mecsek Mts, 3 – SW-Hungary, 4 – Tokaj Mts, 5 – East-Slovakien Basin, 6 – Danube Basin, 7 – Volhyno-Podolian platform, 8 – Precarpathians, 9 – Transcarpathians, 10 – Black Sea Depression, 11 – Caucasus).

Species of foraminifer	Hungary				Vienna Basin	Slovakia		Poland	W-Carpathians	Transylvanian Basin	Moldavia	Ukraine				Russia
	1	2	3	4		5	6					7	8	9	10	11
Cycloforina contorta (D'ORBIGNY)	x	x														
Triloculina intermedia KARRER	x											x	x	x		
Varidentella pseudocostata (VENGLINSKI)	x			x				x						x		
Articulina sp. indet.																
Bolivina antiqua D'ORBIGNY	x											x		x		
Bolivina moldavica DIDKOWSKI	x				x		x		x	x	x	x				
Bolivina moravica CICHA et ZAPLETALOVÁ	x				x				x							
Bolivina sarmatica DIDKOWSKI	x								x		x	x	x	x		
Buliminella elegantissima (D'ORBIGNY)	x										x					x
Fursenkoina acuta (D'ORBIGNY)	x													x		
Fursenkoina sarmatica (VENGLINSKI)																
Caucasina schischkinskye (SAMOYLOVA)	x													x		
Schackoinella imperatoria (D'ORBIGNY)	x			x	x		x	x		x				x		
Lobatula lobatula (WALKER et JACOB)	x	x		x	x		x	x						x		
Nonion bogdanowiczi VOLOSHINOVA	x			x	x		x			x						
Nonion commune (?) (D'ORBIGNY)		x	x	x		x										
Ammonia beccarii (LINNE) s. l.	x		x	x	x	x	x	x		x	x	x	x	x		
Elphidiella aff. *serena* (VENGLINSKI)																
Cribroelphidium ex. gr. *granosum* (D'ORBIGNY)																
Elphidium aculeatum (D'ORBIGNY)	x	x		x	x	x	x	x		x	x	x				
Elphidium crispum (LINNÉ)	x	x						x				x		x		
Elphidium fichtelianum (D'ORBIGNY)	x		x	x	x		x	x			x	x	x	x		
Elphidium hauerinum (D'ORBIGNY)	x	x	x	x		x	x	x		x			x	x		
Elphidium macellum (FICHTEL ET MOLL)	x	x	x	x		x	x			x	x	x	x	x		
Elphidium obtusum (D'ORBIGNY)	x				x					x						
Elphidium reginum (D'ORBIGNY)	x	x	x	x	x	x	x	x		x	x	x		x		
Elphidium aff. *pulvereum* TODD																
Elphidium ex. gr. *puscharovski* SEROVA																

Acknowledgements

Sincere thanks are due to K. GÁL-SOLYMOS and P. PEKKER for the scanning electron microscopy photos that were taken in the Department of Petrology and Geochemistry of Eötvös Loránd University, Budapest.

Systematic descriptions of Sarmatian foraminifers

After LOEBLICH and TAPPAN, 1992

Phylum Protista
Subphylum Sarcodina SCHMARDA, 1871
Class Foraminifera J. J. LEE, 1990
Order Miliolida LANKESTER, 1885
Suborder Miliolina DELAGE et HERUARD, 1896
Superfamily Miliolacea EHRENBERG, 1839
Family Hauerinidae SCHWAGER, 1876
Subfamily Haueininae SCHWAGER, 1876

Genus *Cycloforina* LUCZKOWSKA, 1972

Cycloforina contorta (D'ORBIGNY, 1846)
Pl. 1, Fig. 1.

1846. *Quinqueloculina Juelana* n. sp. – D'ORBIGNY, p. 298, pl. 20, figs 1-3.
1846. *Quinqueloculina contorta* n. sp. – D'ORBIGNY, p. 298, pl. 20, figs 4-6.
1846. *Quinqueloculina Rudolphina* n. sp. – D'ORBIGNY, p. 299, pl. 20, figs 7-9.
1952. *Miliolina contorta* (ORBIGNY) – BOGDANOWICZ, p. 109, pl. 10, fig. 1.
1964. *Quinqueloculina contorta* D'ORBIGNY – KORECZ-LAKY, pl. 2, fig. 10.
1968. *Quinqueloculina contorta* D'ORBIGNY – KORECZ-LAKY, p. 52, pl. 4, fig. 4.
1970. *Quinqueloculina contorta* D'ORBIGNY – DIDKOWSKI, SATANOVSKAJA, p. 22, pl. 9, fig. 6.
1974. *Cycloforina contorta* (D'ORBIGNY) – LUCZKOWSKA, p. 74, pl. 11. figs 2-3, textfig. 26.
1985. *Cycloforina contorta* (D'ORBIGNY) – PAPP, SCHMID, p. 104-105, pl. 100, figs 1-11, pl. 101, figs 1-5.
1991. *Cycloforina contorta* (D'ORBIGNY) – CIMERMAN, Langer, p. 32, pl. 27, figs 7-11.
1991. *Cycloforina juleana* (D'ORBIGNY) – CIMERMAN, LANGER, p. 33, pl. 28, figs 1-2.
1992. *Cycloforina contorta* (D'ORBIGNY) – GÖRÖG, p. 68, pl. 3, figs 1-3.

Material: Few specimens in the biofacies with *Elphidium* and the biofacies with *Articulina* and *Nodophthalmidium*.

Dimensions: Length: 0.54 mm, breadth: 0.4 mm, thickness: 0.24 mm.

Description: Test narrowly oval; periphery angular; five chambers visible externally; chambers one-half a coil in length in cycloforina arragement; chambers long, narrow, uniform in width, their sides flattened, which may be slightly depressed along the keels, two carinae run wide apart on the periphery; elevated middle chambers long with a visible prominent keel; sutures distinct, depressed; wall calcareous, imperforate, thick; surface rough; aperture circular, with a short bifid tooth.

Remarks: The studied specimens are very badly preserved.

Distribution: Late Eocene-Miocene: southern and western Ukraine (BOGDANOWICZ, 1952; DIDKOWSKI, SATANOVSKAJA, 1970); Middle Miocene: W-Ukraine (BOGDANOWICZ, 1952); Badenian: Benczyn, Bogoria, Gliwice Stare, Korytnica, Niechobrz, Rybnica, Wieliczka (Poland) (LUCZKOWSKA, 1974), Vienna Basin (Austria) (D'ORBIGNY, 1946; PAPP, SCHMID, 1985); Badenian to Sarmatian: East-Mecsek Mts (KORECZ-LAKY, 1968); Sarmatian: Zsámbék Basin, Budapest (Hungary) (GÖRÖG, 1992; this study); Recent: Mediterranean (CIMERMAN, LANGER, 1991).

Subfamily Miliolinellinae VELLA, 1957

Genus *Triloculina* D'ORBIGNY, 1926 emend. Luczkowska, 1972

Triloculina intermedia KARRER, 1868
Pl. 1, Fig. 2.

1868. *Triloculina intermedia* n. sp. – KARRER, Die Miocene Foraminiferenfauna von Kostej in Banat. K. Akad. Wiss. Wien, Math.-Naturw. Cl., Sitzber. 58(1), p. 138.,pl.1, fig. 11 (fide Ellis and Messina Catalogue).
1952. *Miliolina intermedia* (KARRER) – BOGDANOWICZ, p. 100, pl. 6, fig. 4.
1958. *Triloculina intermedia* KARRER – VENGLINSKI, p. 66, pl. 5, fig. 26.
1970. *Triloculina intermedia* KARRER – DIDKOWSKI, SATANOVSKAJA, p. 58, pl. 35, fig. 3.
1974. *Triloculina intermedia* KARRER – LUCZKOWSKA, p. 136, pl. 23, fig. 1, textfig. 46/4.
1992. *Triloculina intermedia* KARRER – GÖRÖG, p. 85, pl. 7, figs 3-4.

Material: Few specimens in the biofacies with *Articulina* and *Nodophthalmidium*.

Dimensions: Length: 0.62 mm, breadth: 0.47 mm, thickness: 0.52 mm.

Description: Test irregularly circular, triangular in cross-section; periphery angular, keeled; three chambers visible from outside; two last chambers broad, inflated, tapering at both ends with two prominent edges on the periphery; third chambers small, slightly convex with one edge; sutures depressed and distinct; wall thick; surface smooth; aperture circular or subtriangular with short bifid tooth.

Distribution: Badenian to Sarmatian: Volhyno-Podolian Platform, Precarpathian Foredeep Transcarpathians (Ukraine) (BOGDANOWICZ, 1952; VENGLINSKI, 1958; DIDKOWSKI, SATANOVSKAJA, 1970); Lower Badenian: Karsy, Korytnica, Niskowa (Poland) (LUCZKOWSKA, 1974); Sarmatian: Zsámbék Basin, Budapest (Hungary) (GÖRÖG, 1992; this study).

Genus *Varidentella* LUCZKOWSKA, 1972

Varidentella pseudocostata (VENGLINSKI, 1958)
Pl. 1, Fig. 3.

1958. *Miliolina pseudocostata* (VENGLINSKI) – VENGLINSKI, p. 70, pl. 10, figs 1-3, pl. 11, figs 1-3.

1970. *Quinqueloculina pseudocostata* (VENGLINSKI) – DIDKOWSKI, SATANOVSKAJA, p. 31, pl. 17, fig. 5.
1973. *Quinqueloculina pseudocostata* (VENGLINSKI) – KORECZ-LAKY, pl. 2, fig. 5.
1974. *Quinqueloculina pseudocostata* (VENGLINSKI) – LUCZKOWSKA, p. 140, pl. 26, fig. 7.
1975. *Quinqueloculina pseudocostata* (VENGLINSKI) – VENGLINSKI, p. 159, pl. 13, fig. 3.
1992. *Varidentella pseudocostata* (VENGLINSKI) – GÖRÖG, p. 87, pl. 7, figs 7-9.

Material: Few specimens in the biofacies with *Articulina* and *Nodophthalmidium*.

Dimensions: Length: 0.33 mm, breadth: 0.24 mm, thickness: 0.23 mm.

Description: Test oval to circular, oval or triangular in cross-section; periphery broadly rounded; three to five chambers visible from outside; fifth chamber usually poorly visible; chambers broad, slightly narrower towards the aperture, middle chamber large, slightly convex, oval and tapering at both ends; sutures distinct and depressed; wall thin; surface covered by fine longitudinal striae, which usually disappear near the aperture; aperture large and oval with broad, quadrate, bifurcated tooth.

Distribution: Lower Sarmatian: Transcarpathians (Ukraine) (VENGLINSKI, 1975; DIDKOWSKI, SATANOVSKAJA, 1970), Budy, Grzybów, Rytwiany, Zrecze (Poland) (LUCZKOWSKA, 1974), Tokaj Mts, Zsámbék Basin, Budapest (Hungary) (KORECZ-LAKY, 1973; GÖRÖG, 1992, this study).

Family Tubinellidae RHUMBLER, 1906 nom. transl. MIKHALEVICH, 1988

Genus *Articulina* D'ORBIGNY, 1826

Articulina sp. indet.
Pl. 1, Fig. 4.

Material: About 100 specimens mainly in the biofacies with *Articulina* and *Nodophthalmidium.*

Dimensions: Length: c. 0.6 mm, breadth: c. 0.3 mm.

Remarks: The studied specimens are undeterminable because of their very fragmented tests. Generally the uniserial and initial parts of the test can be found separated.

Distribution: Sarmatian: Budapest (Hungary) (this study).

Order Buliminida FURSENKO, 1958
Superfamily Bolivinacea GLAESSNER, 1937
Family Bolivinidae GLAESSNER, 1937
Genus *Bolivina* D'ORBIGNY, 1839

Bolivina antiqua D'ORBIGNY, 1846
Pl. 1, Fig. 7-8.

1846. *Bolivina antiqua* n. sp. – D'ORBIGNY, p. 240, pl. 14, figs 11-13.
1959. *Bolivina antiqua* D'ORBIGNY – DIECI, p. 66, pl. 5, fig. 26.
1969. *Bolivina antiqua* D'ORBIGNY – CICHA, ZAPLETALOVÁ, pl. 9A, fig. 5.
1970. *Bolivina antiqua* D'ORBIGNY – DIDKOWSKI, SATANOVSKAJA, p. 142, pl. 82, fig. 2.
1975. *Bolivina antiqua* D'ORBIGNY – VENGLINSKI, p. 199, pl. 34, fig. 6.
1985. *Bolivina antiqua* D'ORBIGNY – PAPP, SCHMID, p. 83, pl. 77, figs 1-6.
1998. *Bolivina antiqua* D'ORBIGNY – CICHA et al., p. 83, pl. 44, figs 10-11.

Material: About 20 specimens in the biofacies with *Cibicides*.

Dimensions: Length: 0.32-0.72 mm, breadth: 0.11-0.14 mm.

Description: Test elongate, flattened; periphery subacute; biserial throughout; up to twenty-six chambers; proloculus large; chambers are low and broad and gradually increasing in size; sutures slightly depressed, somewhat curved towards the initial part of the test; there is an angle of 40º between the sutures and the longitudinal axis of the test; wall hyaline; surface finely perforate on the inner part of chambers and imperforate at the sutures; aperture a loop at the apertural face.

Distribution: Aquitanian to Middle Badenian: West-Carpathians (CICHA, ZAPLETALOVÁ, 1961); Karpatian: Vienna Basin (Slovakia) (CICHA, ZAPLETALOVÁ, 1969); Badenian: Italy (DIECI, 1959), Vienna Basin (Austria) (D'ORBIGNY, 1846; PAPP, SCHMID, 1985); Late Badenian to Lower Sarmatian: Volhyno-Podolian Platform, Transcarpathians (Ukraine) (DIDKOWSKI, SATANOVSKAJA, 1970; VENGLINSKI, 1975); Sarmatian: Zsámbék Basin, Budapest (Hungary) (GÖRÖG, 1992; this study).

Bolivina moldavica DIDKOWSKI, 1959
Pl. 1, Figs 11, 13.

1961. *Bolivina moldavica granensis* n. sp. – CICHA, ZAPLETALOVÁ, p. 156, textfig. 29.
1970. *Bolivina moldavica* DIDKOWSKI – DIDKOWSKI, SATANOVSKAJA, p. 143, pl. 82, fig. 7.
1974. *Bolivina moldavica granensis* CICHA et ZAPLETALOVÁ – BRESTENSKÁ, p. 256, pl. 3, fig. 6.
1992. *Bolivina moldavica* DIDKOWSKI – GÖRÖG, p. 98, pl. 9, fig. 2.
1996. *Bolivina moldavica* DIDKOVSKI – FILIPESCU, pl. 5, fig. 7.
2001. *Bolivina moldavica* DIDKOWSKI – KOVÁCS, pl. 2, figs 1-2.
2007. *Bolivina moldavica granensis* CICHA et ZAPLETALOVÁ – SCHÜTZ et al., p. 455, pl. 3, fig. 4.

Material: About 300 specimens in the biofacies with *Cibicides*.

Dimensions: Length: 0.32-0.5 mm, breadth: 0.12-0.2 mm.

Description: Test elongate, compressed; periphery subrounded; biserial throughout; fourteen to twenty chambers; proloculus relatively large; chambers are

low and broad and increasing in size; sutures distinct, slightly depressed, somewhat curved towards the initial part of the test, sometimes bearing one or two lobes; there is an angle c. 60º between the sutures and the longitudinal axis of the test; wall hyaline, perforate; surface ornamented with irregularly anastomosing imperforate costae; aperture a loop on the apertural face.

Distribution: Sarmatian: Volhyno-Podolian Platform (Ukraine), Moldavia (DIDKOWSKI, SATANOVSKAJA, 1970), West-Carpathians (CICHA, ZAPLETALOVÁ, 1961), Transylvanian Basin (Romania) (KOVÁCS, 2001), Romania (FILIPESCU, 1996), Vienna Basin (Austria) (SCHÜTZ et al., 2007), Danube Basin (W-Slovakia) (BRESTENSKÁ, 1974), Zsámbék Basin, Budapest (Hungary) (GÖRÖG, 1992, this study).

Bolivina moravica CICHA et ZAPLETALOVÁ, 1961
Pl. 1, Figs 9, 10.

1961. *Bolivina moravica* n. sp. – CICHA, ZAPLETALOVA, p. 155, textfig. 28.
1975. *Bolivina moravica* CICHA et ZAPLETALOVA – VENGLINSKI, p. 203, pl. 34, fig. 9.
1992. *Bolivina moravica* CICHA et ZAPLETALOVA – GÖRÖG, p. 99, pl. 9, fig. 3.
2007. *Bolivina moravica* CICHA et ZAPLETALOVA – SCHÜTZ et al., p. 455, pl. 3, fig. 5.

Material: Few specimens in the biofacies with *Cibicides*.

Dimensions: Length: 0.3-0.36 mm, breadth: c. 0.09-0.1 mm.

Description: Test slender, flattened; periphery subacute; biserial throughout; fourteen to eighteen chambers; proloculus relatively large; the first eight to twelve chambers are small, low and increasing in size; later chambers broad and low and nearly uniform in size; sutures distinct, strongly deepen, somewhat curved towards the initial part of the test; there is an angle of 45-50º between the sutures and the longitudinal axis of the test; wall hyaline, perforate; surface ornamented with irregularly anastomosing imperforate costae; aperture a loop on the apertural face.

Distribution: Badenian: Transcarpathians (Ukraine) (VENGLINSKI, 1975); Sarmatian: West-Carpathian (CICHA, ZAPLETALOVÁ, 1961), Vienna Basin (Austria) (SCHÜTZ et al., 2007), Zsámbék Basin, Budapest (Hungary) (GÖRÖG, 1992, this study).

Bolivina sarmatica DIDKOWSKI, 1959
Pl. 1, Fig. 12.

1961. *Bolivina* aff. *sarmatica* DIDKOWSKI – CICHA, ZAPLETALOVÁ, p. 152, textfig. 25.
1970. *Bolivina sarmatica* DIDKOWSKI – DIDKOWSKI, SATANOVSKAJA, p. 144, pl. 82, fig. 9. (holotype)
1975. *Bolivina sarmatica* DIDKOWSKI – VENGLINSKI, p. 201, pl. 35, figs 1-4.
1992. *Bolivina sarmatica* DIDKOWSKI – GÖRÖG, p. 101, pl. 9, fig. 5.
1996. *Bolivina sarmatica* DIDKOVSKI – FILIPESCU, pl. 5, fig. 1.
1998. *Bolivina sarmatica* DIDKOWSKI – CICHA et al., p. 84, pl. 43, figs 6-7.

Material: About 50 specimens in the biofacies with *Cibicides*.

Dimensions: Length: c. 0.15 mm, breadth: c. 0.09 mm.

Description: Test very small, elongate, ovoid in outline, flattened; periphery subrounded; biserial throughout; twenty to twenty-two chambers; proloculus small; the early chambers are small, low and strongly increasing in size; later chambers broad and low, the last two chambers are large, nearly sphaerical in shape; septa slightly depressed, somewhat curved towards the apertural end of the test; there is an angle of 60-80º between the sutures and the longitudinal axis of the test; wall hyaline, perforate; surface ornamented with irregularly anastomosing imperforate costae, except the last two chambers; aperture a broad and low loop at the base of apertural face.

Distribution: Sarmatian: Moldavia (DIDKOWSKI, SATANOVSKAJA, 1970), Transcarpathians, Precarpathians, Volhyno-Podolian Platform (Venglinski, 1975), West-Carpathians (CICHA, ZAPLETALOVÁ, 1961), Romania (FILIPESCU, 1996), Zsámbék Basin, Budapest (Hungary) (GÖRÖG, 1992; this study).

Superfamily Buliminacea JONES, 1875
Family Buliminellidae HOFKER, 1951
Genus *Buliminella* CUSHMAN, 1911

Buliminella elegantissima (D'ORBIGNY, 1839)
Pl. 2, Figs 2-4.

1839. *Bulimina elegantissima* n. sp. – D'ORBIGNY, Voyage dans l'Amérique Méridionale; Foraminifères. Strasbourg, France, Levrault 5(5), p. 51, pl. 7, figs 13-14 (fide Ellis and Messina Catalogue).
1970. *Buliminella elegantissima* (D'ORBIGNY) – DIDKOWSKI, SATANOVSKAJA, p. 127, pl. 76, fig. 2.
1973. *Buliminella elegantissima* (D'ORBIGNY) – SEN GUPTA, Schafer, pl. 1, fig. 15.
1992. *Buliminella elegantissima* (D'ORBIGNY) – GÖRÖG, p. 103, pl. 11, figs 9-10.

Material: Over than 550 specimens in the biofacies with *Cibicides*.

Dimensions: Length: 0.23-0.32 mm, diameter: 0.09-0.1 mm.

Description: Test elongate, small; a high trochospiral coil of only two whorls, numerous very broad and low chambers; intercameral sutures slighthly curved and depressed paralleling the long axis of the test; spiral suture depressed; wall thin, perforate; surface smooth; aperture a loop in the

depressed face of the final chamber, the broadest at the upper end.

Distribution: Sarmatian: Black Sea Depression (Ukraine), Moldavia (DIDKOWSKI, SATANOVSKAJA, 1970), Zsámbék Basin, Budapest (Hungary) (GÖRÖG, 1992; this study); Recent: Mediterranean (D'ORBIGNY, 1839), Caribbean Sea (SEN GUPTA, SCHAFER, 1973).

Superfamily Fursenkoinacea LOEBLICH et TAPPAN, 1961
Family Fursenkoinidae LOEBLICH et TAPPAN, 1961
Genus *Fursenkoina* LOEBLICH et TAPPAN, 1961

Fursenkoina acuta (D'ORBIGNY, 1846)
Pl. 1, Fig. 14.

1846. *Polymorphina acuta* n. sp. – D'ORBIGNY, p. 234, pl. 13, figs 4-5, pl. 14, figs 5-7.
1848. *Virgulina schreibersiana* n. sp. – CZJZEK, p. 147, pl. 13, figs 18-21.
1958. *Virgulina schreibersiana* CZJZEK – VENGLINSKI, p. 136, pl. 29, fig. 10.
1959. *Virgulina schreibersiana* CZJZEK – DIECI, p. 65, pl. 5, fig. 24.
1968. *Virgulina schreibersiana* CZJZEK – KORECZ-LAKY, p. 101, pl. 5, fig. 4.
1969. *Stainforthia schreibersiana* (CZJZEK) – CICHA, ZAPLETALOVÁ, p. 127, pl. 6A, fig. 7.
1969. *Fursenkoina schreibersiana* (CZJZEK) – RÖGL, p. 98, pl. 4, fig. 6.
1970. *Virgulina schreibersiana* CZJZEK – DIDKOWSKI, SATANOVSKAJA, p. 128, pl. 76, fig. 9.
1973. *Virgulina schreibersiana* CZJZEK – KORECZ-LAKY, pl. 7, fig. 7.
1982. *Fursenkoina schreibersiana* (CZJZEK) – SZCZECHURA, pl. 7, fig. 12.
1985. *Fursenkoina acuta* (D'ORBIGNY) – PAPP, SCHMID, p. 82, pl. 75, figs 1-6.
1991. *Virgulina acuta* (D'ORBIGNY) – CIMERMAN, LANGER, p. 64, pl. 67, figs 1-2.
1992. *Fursenkoina acuta* (D'ORBIGNY) – GÖRÖG, p. 104, pl. 9, figs 11-12.
1998. *Fursenkoina acuta* (D'ORBIGNY) – CICHA et al., p. 97, pl. 55, fig. 1.
1999. *Fursenkoina acuta* (D'ORBIGNY) – BALDI, p. 207, pl. 7, figs 1-2.

Material: About 20 specimens in the biofacies with *Cibicides*.

Dimensions: Length: 0.5-0.8 mm, breadth: 0.13-0.24 mm.

Description: Test narrow, elongate, ovate in cross section; periphery subrounded; biserial, plane of biseriality twists about the test axis, chambers high and narrow, slightly inflated; sutures oblique, depressed; wall hyaline, very thin and very finely perforate, surface smooth; aperture narrow, elongate with a denticulate toothplate.

Remarks: We accept the opinion of PAPP and SCHMID (1985) that *Fursenkoina acuta* D'ORBIGNY and *F. schreibersiana* (CZJZEK) are synonymous.

Distribution: Karpatian: Molassenzone (Niederösterreich) (RÖGL, 1969), Vienna Basin (Slovakia) (CICHA, ZAPLETALOVÁ, 1969); Badenian: Italy (DIECI, 1959), Carpathian Foredeep (Poland) (SZCZECHURA, 1982), Vienna Basin (Austria) (D'ORBIGNY, 1846; PAPP, SCHMID, 1985), East-Mecsek Mts, SW-Hungary (KORECZ-LAKY, 1968; BÁLDI, 1999); Badenian to Sarmatian: Transcarpathians (Ukraine) (VENGLINSKI, 1958; DIDKOWSKI, SATANOVSKAJA, 1970); Sarmatian: Zsámbék Basin, Budapest (Hungary) (GÖRÖG, 1992; this study); Recent: Mediterranean (CIMERMAN, LANGER, 1991).

Fursenkoina sarmatica (VENGLINSKI, 1958)
Pl. 2, Fig. 1.

1958. *Virgulina sarmatica* n. sp. – VENGLINSKI, p. 137, pl. 29, figs 11-12.
1970. *Virgulina sarmatica* VENGLINSKI – DIDKOWSKI, SATANOVSKAJA, p. 128, pl. 76, fig. 5.

Material: Few specimens in the biofacies with *Cibicides*.

Dimensions: Length: 0.3 mm, breadth: 0.16 mm.

Description: Test elongate, nearly circular in cross section; periphery subrounded; biserial, plane of biseriality twists about the test axis, chambers elongate, inflated; sutures oblique, depressed; wall hyaline, very thin and very finely perforate, surface smooth; aperture narrow, elongate with a denticulate toothplate.

Remarks: This species differs from *Fursenkoina acuta* (D'ORBIGNY) in its less slender test shape and smaller dimensions.

Distribution: Badenian: Transcarpathians (Ukraine) (VENGLINSKI, 1958), Sarmatian: Budapest (Hungary) (this study).

Superfamily Delosinacea PARR, 1950
Family Caucasinidae N. K. BYKOVA, 1950
Subfamily Caucasininae N. K. BYKOVA, 1959
Genus *Caucasina* KHALILOV, 1951

Caucasina schichkinskye (SAMOYLOVA, 1947)
Pl. 2, Fig. 5.

1937. *Bulimina elongata* var. *lappa* CUSHMAN et PARKER – CUSHMAN, PARKER, Notes on some European Eocene species of Bulimina. Contr. Cushman Lab. Foram. Res. 13(2), p. 51, pl. 7, fig. 8 (fide Ellis and Messina Catalogue).
1937. *Bulimina elongata* var. *subulata* CUSHMAN et PARKER – CUSHMAN, PARKER, Notes on some European Eocene species of Bulimina. Contr. Cushman Lab. Foram. Res. 13(2), p. 51, pl. 7, figs 6-7 (fide Ellis and Messina Catalogue).
1947. *Bulimina schichkinskye* n. sp. – SAMOYLOVA, On some new and characteristic species of foraminifera from the upper Paleogene in the Crimea. Soc. Nat. Moscou, Bull., Moscou, n. s. 52, (Sect. Geol. 22), 4, pp. 82, 100, pl. 10 (fide Ellis and Messina Catalogue).

1951. *Bulimina elongata* var. *lappa* CUSHMAN et PARKER – MARKS, p. 57, pl. 7, fig. 14.
1951. *Bulimina elongata* var. *subulata* CUSHMAN et PARKER – MARKS, p. 57, pl. 7, fig. 13.
1958. *Caucasina schichkinskye* SAMOYLOVA – VENGLINSKI, p. 135, pl. 29, figs 4-9.
1969. *Caucasina schichkinskye* (SAMOYLOVA) – RÖGL, p. 98, pl. 4, figs 7-8.
1970. *Caucasina lalovi* VENGLINSKI – DIDKOWSKI, SATANOVSKAJA, p. 134, pl. 79, fig. 1.
1975. *Caucasina khalilovi* LOEBLICH et TAPPAN *sarmatica* n. ssp. – VENGLINSKI, p. 193, pl. 31, figs 6-38.
1975. *Caucasina subaculeata* n. sp. – VENGLINSKI, p. 194, pl. 31, figs 1-5.
1992. *Caucasina schichkinskye* (SAMOYLOVA) – GÖRÖG, p. 105, pl. 9, fig. 13, pl. 10, fig. 1.
1998. *Bulimina subulata* CUSHMAN et PARKER – CICHA et al., p. 87, pl. 46, figs 15-19.
1998. *Bulimina schichkinskayae* SAMOYLOVA– CICHA et al., p. 87, pl. 47, figs 2-4.
1999. *Bulimina f. subulata* CUSHMAN et PARKER – BALDI, p. 200, pl. 3, fig. 1.
2007. *Caucasina subulata* CUSHMAN et PARKER – SCHÜTZ et al., p. 456, pl. 4, fig. 1.

Material: Abut 10 specimens in the biofacies with *Elphidium* and about 70 specimens in the biofacies with *Cibicides*.

Dimensions: Length: 0.23-0.25, diameter: 0.1-0.16 mm.

Description: Test elongate, subcylindrical to flaring, base bluntly rounded; initial in a low trochospiral coil of four to six chambers per whorl, later stage high spired, reduced to three chambers per whorl although not regularly triserial, later chambers inflated, nearly sphaerical, their size increases gradually; sutures depressed, distinct and curved, the sutures between the whorls nearly at right angle to the longitudinal axis of the test; wall finely perforate; surface smooth or may have short spines and nodes on the proloculus and basal part of early chambers; aperture an elongate narrow loop extending up the face of the final chamber, the posterior margin curving inward in a broad flaplike toothplate, the projecting anterior margin bordered by a narrow raised lip.

Variability: The shape of the test (subcylindrical to nearly sphaerical) and the presence of spines and nodes on the basal part are varied.

Remarks: Most of the studied specimens are small and squat with few spines on the basal part.

Distribution: Late Eocene to Sarmatian. Middle Oligocene: Caucasus and Crimea (Russia) (SAMOYLOVA, 1947); Late Eocene, Badenian: Moravia, Carpathian Foredeep (Czech Republic) (CICHA et al., 1998); Karpatian: Molassenzone (Niederösterreich) (RÖGL, 1969); Badenian: SW-Hungary (BÁLDI, 1999); Late Badenian to Sarmatian: Transcarpathians (Ukraine) (VENGLINSKI, 1958, 1975; DIDKOWSKI, SATANOVSKAJA, 1970); Sarmatian: Zsámbék Basin, Budapest (Hungary) (GÖRÖG, 1992; this study).

Order Rotaliida LANKESTER, 1885
Superfamily Glabratellacea LOEBLICH et TAPPAN, 1964
Family Glabratellidae LOEBLICH et TAPPAN, 1964
Genus *Schackoinella* WEINHANDL, 1958

Schackoinella imperatoria (D'ORBIGNY, 1846)
Pl. 2, Fig. 6.

1846. *Rosalina imperatoria* n. sp. – D'ORBIGNY, p. 176, pl. 10, figs 16-18.
1877. *Calcarina carpenteri* KARRER– KARRER, p. 387, pl. 16, fig. 58.
1958. *Discorbis imperatorius* (D'ORBIGNY) – VENGLINSKI, p. 146, pl. 31, fig. 5.
1964. *Discorbis imperatorius* (D'ORBIGNY) – KORECZ-LAKY, pl. 1, fig. 11.
1967. *Glabratella plana* n. sp. – LUCZKOWSKA, p. 237, pl. 8, figs 13-15.
1970. *Discorbis imperatorius* (D'ORBIGNY) – DIDKOWSKI, SATANOVSKAJA, p. 79, pl. 51, fig. 3.
1973. *Discorbis imperatorius* (D'ORBIGNY) – KORECZ-LAKY, p. 258, pl. 1, fig. 2.
1974. *Glabratella imperatoria* (ORBIGNY) – BRESTENSKÁ, p. 258, pl. 4, figs 1-3.
1982. *Glabratella imperatoria* (D'ORBIGNY) – SZCZECHURA, pl. 8, figs 8-11.
1985. *Schackoinella imperatoria* (D'ORBIGNY) – PAPP, SCHMID, p. 66, pl. 60, figs 1-5.
1991. *Conorbella imperatoria* (D'ORBIGNY) – CIMERMAN, LANGER, p. 68, pl. 72, figs 9-11.
1992. *Schackoinella imperatoria* (D'ORBIGNY) – GÖRÖG, pp. 108-109, pl. 10, figs 5-6.
1998. *Schackoinella imperatoria* (D'ORBIGNY) – CICHA et al., p. 125, pl. 60, figs 7-9.
2001. *Schackoinella imperatoria* D'ORBIGNY – KOVACS, pl. 3, figs 6/8.
2007. *Schackoinella imperatoria* (D'ORBIGNY) – SCHÜTZ et al., p. 456, pl. 4, figs 4a-f.

Material: About 50 specimens in the biofacies with *Cibicides*.

Dimensions: Diameter: 0.17-0.27 mm.

Description: Test small, trochospiral, nearly circular; on the spiral side two or two and half whorls, the inner whorl consists four to six globular chambers; six to seven chambers on the last whorl; on the dorsal side each rapidly enlarging chamber bears small pointed spines resulting a stellate peripheral outline; ventral side umbilicate, umbilicus open; sutures indistinct and depressed, slightly inflected on the dorsal side, depressed and radiate on the ventral side; wall optically radial, finely perforate; surface ornamented with radiating striae from the umbilicus and fine granulosity on the ventral side; aperture an interiomarginal umbilical slit.

Variability: We accept the opinion of BRESTENSKÁ, 1974 that the more flattened stellate outline, the radially elongate chambers and the horizontal spines of *Calcarina carpenteri* KARRER and *Glabratella plana* LUCZKOWSKA are derived from the dimorphism of the schizont and gamont forms.

Remarks: The studied specimens are badly-preserved.

Distribution: Late Badenian to Lower Sarmatian: Transcarpathians (Ukraine) (VENGLINSKI, 1958; DIDKOWSKI, SATANOVSKAJA, 1970); Lower Sarmatian: Vienna Basin (D'ORBIGNY, 1846; PAPP, SCHMID, 1985; SCHÜTZ et al., 2007; CICHA et al., 1998), Transylvanian Basin (Romania) (KOVÁCS, 2001), Tokaj Hill, Zsámbék Basin, Budapest (Hungary) (KORECZ-LAKY, 1964, 1973; GÖRÖG, 1992, this study), Carpathian Foredeep (Poland) (SZCZECHURA, 1982; LUCZKOWSKA, 1967), Danube Basin (W-Slovakia) (BRESTENSKÁ, 1974); Recent: Mediterranean (CIMERMAN, LANGER, 1991).

Superfamily Planurbulinacea SCHWAGER, 1877
Family Cibicididae CUSHMAN, 1927
Subfamily Cibicidinae CUSHMAN, 1927
Genus *Lobatula* FLEMING, 1828

Lobatula lobatula (WALKER et JACOB, 1798)
Pl. 2, Figs 7-8, 11-12.

1798. *Nautilus lobatulus* n. sp. – WALKER, JACOB, In KANMACHER, F., Adams' Essays on the microscope. Dillon and Keating, London, England, p. 642, pl. 14, fig. 36 (fide Ellis and Messina Catalogue).
1798. *Nautilus tuberosus* n. sp. – FICHTEL, MOLL, p. 111, pl. 20, figs g-k.
1846. *Truncatulina lobatula* D'ORBIGNY – D'ORBIGNY, p. 168, pl. 9, figs 18-23.
1846. *Anomalina variolata* D'ORBIGNY – D'ORBIGNY, p. 176, pl. 9, figs 27-29.
1958. *Cibicides certus* VENGLINSKI – VENGLINSKI, p. 160, pl. 35, fig. 5.
1958. *Cibicides vyschcoviensis* n. sp. – VENGLINSKI, p. 161, pl. 36, figs 1-2.
1961. *Cibicides lobatulus* (WALKER et JACOB) – DUPEUBLE, p. 197, pl. 1, figs 1,4, pl. 2, figs 5,6,7.
1959. *Cibicides lobatulus* (WALKER et JACOB) – DIECI, p. 100, pl. 8, fig. 11.
1964. *Cibicides lobatulus* (WALKER et JACOB) – KORECZ-LAKY, pl. 3, fig. 1.
1968. *Cibicides lobatulus* (WALKER et JACOB) – KORECZ-LAKY, p. 122, pl. 9, fig. 16.
1969. *Cibicides lobatulus* (WALKER et JACOB) – CICHA, ZAPLETALOVA, p. 143, pl. 11A, fig. 1.
1970. *Cibicides lobatulus* (WALKER et JACOB) – DIDKOWSKI, SATANOVSKAJA, p. 93, pl. 60, fig. 1.
1973. *Cibicides lobatulus* (WALKER et JACOB) – KORECZ-LAKY, pl. 1, fig. 10.
1973. *Cibicides lobatulus* (WALKER et JACOB) – BROOKS, pl. 10, figs 17-18.
1973. *Cibicides lobatulus* (WALKER et JACOB) – SEN GUPTA, SCHAFER, pl. 2, figs 4-5 .
1974. *Cibicides lobatulus* (WALKER et JACOB) – BRESTENSKA, p. 264, pl. 4, fig. 5.
1974. *Cibicides lobatulus* (WALKER et JACOB) – AMATO, p. 107, pl. 51, figs 3a-c.
1975. *Cibicides variolatus* (D'ORBIGNY) – VENGLINSKI, p. 180, pl. 25, figs 2-5.
1973. *Cibicides datensis* FUJITA-ITO – KORECZ-LAKY, pl. 1, fig. 11.
1982. *Cibicides lobatulus* (WALKER and JACOB) – SZCZECHURA, pl. 13, figs 1-3.
1984. *Cibicides lobatulus* (WALKER et JACOB) – RÖGL, HANSEN, p. 68, pl. 26, figs 9-11.
1985. *Cibicides lobatulus* (WALKER et Jacob) – Papp, Schmid, pp. 64,65, pl. 56, figs 1-5, pl. 57, figs 1-3.
1991. *Cibicides lobatulus* (WALKER et JACOB) – CIMERMAN, LANGER, p. 71, pl. 75, figs 1-4.
1992. *Cibicides lobatulus* (Walker et JACOB) – GÖRÖG, pp. 109-110, pl. 10, figs 7-8.
1996. *Lobatula lobatula* (WALKER et JACOB) – FILIPESCU, pl. 5, fig. 2.
1998. *Lobatula lobatula* (WALKER et JACOB) – CICHA et al., p. 111, pl. 63, figs 23-25.
1999. *Cibicides lobatulus* (WALKER et JACOB) – BALDI, pp. 205-206, pl. 5, figs 5-8, pl. 6, figs 1-6.
2000. *Cibicides lobatulus* (WALKER et JACOB) – SZCZECHURA, pl. 6, figs 9-10.
2007. *Lobatula lobatula* (WALKER et JACOB) – SCHÜTZ et al., p. 456-457, pl. 4, figs 5a-b.

Material: About 8200 specimens in the biofacies with *Cibicides*.

Dimensions: Maximum diameter: 0.42-0.56 mm.

Description: Test large, trochospiral, variable in shape; periphery carinate, often irregular; umbilical side gently convex with seven to eight chambers; spiral side flat to irregular depending on the substrate, eight to nine chambers visible; sutures thickened, depressed, oblique on the spiral side, slightly curved backward at the periphery on the umbilical side; lobulate wall calcareous; dorsal side coarsely perforate; ventral side finely perforate; sutures, apertural lip and peripherial keel imperforate; surface smooth; aperture an interiomarginal, equatorial arch bordered by a lip and extending onto the spiral side beneath a narrow folium.

Remarks: The shape of the test is very variable because the species lives attached on subtrates. This ecological fact is the cause of the difference between *Truncatulina lobatula* and *Anomalina variolata* described by D'ORBIGNY, 1846 and between *Cibicides certus* and *C. vyschcoviensis* described by VENGLINSKI, 1958.

Distribution: Late Oligocene: SW-France (AMATO, 1975); Karpatian: Vienna Basin (Slovakia) (CICHA, ZAPLETALOVÁ, 1969); Badenian: Italy (DIECI, 1959), Vienna Basin (D'ORBIGNY, 1846; PAPP, SCHMID, 1985), East-Mecsek Mts, SW-Hungary (Hungary) (KORECZ-LAKY, 1968; BÁLDI, 1999); Badenian to Lower Sarmatian: Transcarpathians (Ukraine) (VENGLINSKI, 1958, 1975; DIDKOWSKI, SATANOVSKAJA, 1970); Sarmatian: Carpathian Foredeep (Poland) (SZCZECHURA, 1982, 2000), Vienna Basin (Austria) (SCHÜTZ et al., 2007), Danube Basin (W-Slovakia) (BRESTENSKÁ, 1974), Romania (FILIPESCU, 1996), East-Mecsek Mts., Tokaj Mts, Zsámbék Basin, Budapest (Hungary) (KORECZ-LAKY, 1964, 1968, 1973; GÖRÖG, 1992; this study); Pliocene: Italy (FICHTEL, MOLL, 1798; RÖGL, HANSEN, 1984); Recent: England (WALKER, JACOB, 1798), Caribbean-Antilles region (BROOKS, 1973), Mediterranean (DUPEUBLE, 1961; CIMERMAN, LANGER, 1991).

Superfamily Nonionacea SCHULTZE, 1854
Family Nonionidae SCHULTZE, 1854
Subfamily Nonioninae SCHULTZE, 1854
Genus *Nonion* DE MONFORT, 1808

Nonion bogdanowiczi VOLOSHINOVA, 1952
Pl. 2, Figs 9, 13.

1952. *Nonion bogdanowiczi* n. sp. – VOLOSHINOVA, p. 19, pl. 1, figs 7-8.
non 1958. *Nonion bogdanowiczi* VOLOSHINOVA – VENGLINSKI, p. 108, pl. 21, fig. 4.
1960. *Nonion bogdanowiczi* VOLOSHINOVA – STANCHEVA, p. 16, pl. 3, fig. 4.
non 1970. *Nonion bogdanowiczi* VOLOSHINOVA – DIDKOWSKI, SATANOVSKAJA, p. 96, pl. 62, fig. 4.
1973. *Nonion bogdanowiczi* VOLOSHINOVA – KORECZ-LAKY, pl. 5, fig. 7.
1974. *Florilus bogdanowiczi* (VOLOSHINOVA) – BRESTENSKA, p. 267, pl. 8, fig. 3.
1992. *Nonion bogdanowiczi* VOLOSHINOVA – GÖRÖG, p. 111, pl. 11, fig. 4.
1998. *Nonion bogdanowiczi* VOLOSHINOVA – CICHA et al., p. 113, pl. 66, fig. 6.
2001. *Nonion bogdanowiczi* VOLOSHINOVA – KOVACS, pl. 5, figs 2-5.
2005. *Nonion bogdanowiczi* VOLOSHINOVA – SUCIU, pl. 2, fig. 7.
2007. *Nonion bogdanowiczi* VOLOSHINOVA – SCHÜTZ et al., p. 457, pl. 5, figs 2a-b.

Material: About 50 specimens in the biofacies with *Elphidium*, about 160 specimens in the biofacies with *Cibicides* and about 10 in the biofacies with *Articulina* and *Nodophthalmidium*.

Dimensions: Diameter: 0.13-0.32 mm, thickness: 0.04-0.13 mm.

Description: Test small; planispiral, involute, nearly rounded or oval in outline, laterally compressed and biumbilicate; periphery rounded; six to eight chambers in the final whorl; chambers more or less inflated and rapidly increasing in size; sutures distinct, slightly curved back, flat or slightly depressed at the periphery and deepen towards the umbilicus; umbilicus flat or slightly depressed, partially to completely filled with pustules at the inner margins of the chambers; wall thin and finely perforate; surface smooth except for the granules; aperture a low interiomarginal and equatorial slit at the base of apertural face.

Remarks: The specimen described and illustrated by Didkowski and Satanovskaja (1970) differs from the holotype because of more chambers on the last whorl and the chambers do not increase gradually.

Distribution: Sarmatian: Crimea-Caucasus region and East-Precaucasus (Russia, Ukraine) (VOLOSHINOVA, 1952), NW-Bulgaria (STANCHEVA, 1960), Bega Basin (Romania) (CICHA et al., 1998), Transylvanian Basin (Romania) (KOVÁCS, 2001; SUCIU, 2005), Zsámbék Basin, Tokaj Mts, Budapest (Hungary) (GÖRÖG, 1992; KORECZ-LAKY, 1973; this study), Vienna Basin (Austria) (SCHÜTZ et al., 2007), Danube Basin (W-Slovakia) (BRESTENSKÁ, 1974).

Nonion commune (D'ORBIGNY, 1825)
Pl. 2, Fig. 11.

1798. *Nautilus scapha* n. sp. – FICHTEL, MOLL, p. 105, pl. 19, figs d-f.
1846. *Nonionina communis* D'ORBIGNY – D'ORBIGNY, p. 106, pl. 5, figs 7-8.
1951. *Nonion boueanum* (d'Orbigny) – MARKS, P. 48, PL. 5, FIG. 17A,B.
1951. *Nonion scaphum* (FICHTEL and MOLL) – MARKS, p. 49, pl. 5, fig. 16a,b.
1952. *Nonion boueanus* (ORBIGNY) – VOLOSHINOVA, p. 18, pl. 1, figs 1-5.
1959. *Nonion commune* (D'ORBIGNY) – DIECI, p. 53, pl. 4, fig. 25.
1959. *Nonion boueanum* (D'ORBIGNY) – DIECI, p. 53, pl. 4, figs 23-24.
1968. *Nonion boueanum* (D'ORBIGNY) – KORECZ-LAKY, p. 88, pl. 5, fig. 16.
1969. *Nonion scaphum* (FICHTEL et MOLL) – RÖGL, p. 102, pl. 5, fig. 19.
1970. *Florilus boueanus* (ORBIGNY) – DIDKOWSKI, SATANOVSKAJA, p. 102, pl. 65, fig. 3.
1973. *Nonion boueanum* (D'ORBIGNY) – KORECZ-LAKY, pl. 7, fig. 20.
1982. *Nonion boueanum* (D'ORBIGNY) – KORECZ-LAKY, pl. 9, fig. 6.
1982. *Florilus boueanus* (D'ORBIGNY) – SZCZECHURA, pl. 14, fig. 11.
1984. *Nonion commune* (D'ORBIGNY) – RÖGL, HANSEN, p. 66, pl. 24, figs 1-2.
1985. *Nonion commune* (D'ORBIGNY) – PAPP, SCHMID, p. 45, pl. 34, figs 1-5.
1997. *Nonion commune* (D'ORBIGNY) – ZLINSKA, p. 291, pl. 1, fig. 3.
1998. *Nonion commune* (D'ORBIGNY) – CICHA et al., p. 113, pl. 66, figs 1-2.
1999. *Nonion commune* (D'ORBIGNY) – BALDI, pp. 210-211, pl. 10, figs 4-5.
2005. *Nonion commune* D'ORB. – KOVACOVA, HUDACKOVA, pl. 2, fig. 10.
2007. *Nonion commune* (D'ORBIGNY) – SCHÜTZ et al., p. 457, pl. 5, figs 3a-b.
2007. *Nonion commune* (D'ORBIGNY) – OBLAK, pp. 302-303, pl. 3, fig 1.

Material: About 20 specimens in the biofacies with *Elphidium*, about 40 specimens in the biofacies with *Cibicides*.

Dimensions: Diameter: 0.35-0.37 mm, thickness: 0.13-0.16 mm.

Description: Test planispiral, involute, ovate in outline, laterally compressed and biumbilicate; periphery rounded; nine to eleven chambers in the final whorl; chambers rapidly increasing in size; sutures curved only in the last quarter and slightly depressed; umbilicus flat or slightly depressed, partially to completely filled with pustules on the somewhat crenulate inner margins of the chambers; peripheral outline smooth; wall optically granular, surface smooth except for the granules; pustulose border around the aperture, aperture a low

interiomarginal and equatorial slit at the base of apertural face.

Remarks: According to the revision of RÖGL and HANSEN (1984), the holotype described by D'ORBIGNY (1846) is identical with *Nautilus scapha* described by FICHTEL and MOLL (1798). In this case the valid name of this species should be *Nonion scaphum*. We accept the opinion of PAPP and SCHMID (1985) that the type of test with wavy outline that was often assigned to "*Nonion boueanum*" based on D'ORBIGNY (1846), is the ecological variation of *N. commune*.

Distribution: Karpatian: Molassenzone (Niederösterreich) (RÖGL, 1969); Karpatian to Badenian: Vienna Basin (D'ORBIGNY, 1846; PAPP, SCHMID, 1985; SCHÜTZ ET AL., 2007; KOVÁČOVÁ, HUDÁČKOVÁ, 2005), Carpathian Foredeep (Poland) (SZCZECHURA, 1982); Badenian: Volhyno-Podolian Platform, Precarpathians, Transcarpathians (Ukraine), Crimea-Caucasus region, Kuban (VOLOSHINOVA, 1952; DIDKOWSKI, SATANOVSKAJA, 1970), Slovenia (OBLAK, 2007); Badenian to Sarmatian: East-Mecsek Mts, Tokaj Mts, SW-Hungary, Budapest (KORECZ-LAKY, 1968, 1973, 1982; BÁLDI, 1999; this study), Italy (DIECI, 1959); Sarmatian: Eastern Slovakian Basin (Slovakia) (ZLINSKÁ, 1997); Recent: Adriatic Sea (RÖGL, HANSEN, 1984).

Superfamily Rotaliacea EHRENBERG, 1839
Family Rotaliidae EHRENBERG, 1839
Subfamily Ammoniinae SAIDOVA, 1981
Genus *Ammonia* BRÜNNICH, 1772

Ammonia beccarii (LINNE, 1758) s. l.
Pl. 2, Figs 14-18.

1758. *Nautilus beccarii* n. sp. – LINNAEUS, Systema Naturae, Holmiae, Suecia, 1, p. 710, pl. 1, figs 1a-c (fide Ellis and Messina Catalogue).
1839. *Rosalina parkinsoniana* n. sp. – D'ORBIGNY, Foraminifères, in SAGRA, R. (ed.) Histoire physique et naturelle de l'Ile de Cuba, A. Bertrand, Paris, France, p. 99, vol. 8, pl. 4, figs 25-27 (fide Ellis and Messina Catalogue).
1846. *Rosalina viennensis* n. sp. – D'ORBIGNY, p. 177, pl. 10, figs 22-24.
1951. *Rotalia viennensis* (D'ORBIGNY) – MARKS, p. 65, pl. 8, figs 7a-c.
1958. *Rotalia beccarii* (LINNE) – VENGLINSKI, p. 151, pl. 33, figs 1-2.
1959. *Rotalia beccarii* (LINNEO) – DIECI, p. 80, pl. 6, fig. 29.
1963. *Ammonia beccarii* (LINNE) – PAPP, p. 281, pl. 14, figs 1-17.
1964. *Rotalia beccarii* (LINNE) – KORECZ-LAKY, pl. 1, fig. 9.
1964. *Streblus pseudobeccarii* n. sp. – PUTRYA, On some new species of Miocene foraminifera from eastern Ciscarpathia. Pal. Zhur. 3, pp. 129-130, pl. 15, figs 3a-c, 4a-c (fide Ellis and Messina Catalogue).
1968. *Rotalia beccarii* (LINNE) – KORECZ-LAKY, p. 109, pl. 5, fig. 18.
1969. *Ammonia beccarii* (LINNE) – RÖGL, p. 90, pl. 4, fig. 2.
1970. *Streblus beccarii* (LINNE) – DIDKOWSKI, SATANOVSKAJA, p. 113, pl. 69, fig. 5.
1973. *Rotalia beccarii* (LINNE) – KORECZ-LAKY, pl. 5, fig. 10.
1974. *Ammonia* ex. gr. *beccarii* (LINNAEUS) – BRESTENSKA, p. 67, pl. 3, figs 3-4.
1975. *Ammonia beccarii* (LINNE) – VENGLINSKI, p. 189, pl. 29, fig. 5, pl. 30, fig. 1,3.
1975. *Ammonia pseudobeccarii* (PUTRYA) – VENGLINSKI, p. 190, pl. 29, fig. 3.
1982. *Ammonia beccarii* (LINNÉ) – SZCZECHURA, pl. 9, figs 2,3,8,9.
1985. *Ammonia beccarii* (LINNÉ) – PAPP and SCHMID, p. 67, pl. 61, figs 1-5.
1992. *Ammonia beccarii* (LINNÉ) – GÖRÖG, pp. 114-115, pl. 11, figs 1-3.
1996. *Ammonia beccarii* (LINNE) – FILIPESCU, pl. 3, fig. 2.
1997. *Ammonia beccarii* (LINNE) – ZLINSKA, p. 291, pl. 1, figs 4-5.
1998. *Ammonia viennensis* (D'ORBIGNY) – CICHA et al., p. 79, pl. 74, figs 1-3.
1999. *Ammonia beccarii* (LINNE) – BALDI, pp. 197-198, pl. 1, figs 1-2.
2001. *Ammonia beccarii* (LINNE) – KOVACS, pl. 4, fig. 3.
2007. *Ammonia pseudobeccarii* (PUTRIA) – SCHÜTZ et al., p. 457, pl. 6, figs 4a-c.

Material: About 10 specimens in the biofacies with *Elphidium*, about 3370 specimens in the biofacies with *Cibicides* and about 170 in the biofacies with *Articulina* and *Nodophthalmidium*.

Dimensions: Diameter: 0.24-0.44 mm.

Description: Test biconvex, round, trochospiral with two and half to three whorls; periphery rounded or subrounded; eleven to twenty chambers on the more or less convex spiral side, the size of the sometimes slightly inflated chambers increases gradually; sutures distinct, depressed (giving a stellate shape) or elevated and curved back of the dorsal side; on the ventral side the final whorl deeply incised umbilical, radial, and intraseptal spaces, umbilicus open or having large umbilical plug surrounded by umbilical fissure, sutural fissures straight or branching and appear feathered on the umbilical side, often bordered by folium from each chamber in the final whorl; wall thin, finally perforate, optically radial; surface smooth except the umbilical region with sutural fissures; primary aperture an interiomarginal extraumbilical slit extending under the folium.

Remarks: The wide morphological variability of *Ammonia beccarii* s. l. (mainly *A. beccarii* forma *beccarii*, *A. beccarii* forma *tepida*, *A. beccarii* forma *parkinsoniana*) makes its taxonomic status uncertain. Many authors consider different morphotypes as ecophenotypes (e.g. WALTON, SLOAN, 1990; DEBENAY et al., 1998). However, the recent microhabitat and DNA studies of *Ammonia beccarii* showed that the different morphotypes are true different species in most cases (e. g. PAWLOWSKI et al., 1995, HOLZMANN, PAWLOWSKI, 1997, 2000, HOLZMANN et al., 1996, 1998). Some of the studied specimens seem to be very similar to the recent *A. beccarii* forma *parkinsoniana* and *A. pseudobeccarii* described by PUTRYA (1964) because of the lack of interlocular spaces on the spiral and umbilical sides

and the presence of the prominent umbilical plug, and less or no ornamented short sutural fissures. The synonym list includes the primary description and the descriptions from the Miocene sequences.

Distribution: Miocene to Recent. Recently widely distributed over the world. Miocene: Karpatian: Molassenzone (Niederösterreich) (RÖGL, 1969); Karpatian to Sarmatian: Transcarpathian (Ukraine) (VENGLINSKI, 1958, 1975), Volhyno-Podolian Platform, Precarpathians, Transcarpathians (Ukraine), (PUTRYA, 1964; DIDKOWSKI, SATANOVSKAJA, 1970); Badenian: Moldoveneşti (Romania) (FILIPESCU, 1996), East-Mecsek Mts, SW-Hungary (KORECZ-LAKY, 1968; BÁLDI, 1999), Vienna Basin (Austria) (D'ORBIGNY, 1846), Italy (DIECI, 1959); Badenian to Sarmatian: Carpathian Foredeep (Poland) (SZCZECHURA, 1982); Sarmatian: Danube and East-Slovakian Basin (Slovakia) (BRESTENSKÁ, 1974; ZLINSKÁ, 1997); Vienna Basin (Austria) (PAPP, 1963; SCHÜTZ et al., 1997); Tokaj Hill, SW-Hungary, Zsámbék Basin, Budapest (Hungary) (KORECZ-LAKY, 1964, 1973; GÖRÖG, 1992; this study), Transylvanian Basin (Romania) (KOVÁCS, 2001), Moldavia (DIDKOWSKI, SATANOVSKAJA, 1970).

Family Calcarinidae SCHWAGER, 1876
Genus *Elphidiella* CUSHMAN, 1936

Elphidiella aff. *serena* VENGLINSKI, 1958
Pl. 3, Figs 1-2.

1958. *Nonion serenus* n. sp. – VENGLINSKI, p. 102, pl. 20, fig. 6-7.

Material: About 20 specimens in the biofacies with *Elphidium*.

Dimensions: Diameter: 0.26-0.32, thickness: 0.13-0.18 mm.

Description: Test planispiral, involute, bilaterally symmetrical; periphery rounded; ten to thirteen chambers in the final whorl; no true ponticuli or fossettes but may have retral processes, after the early chambers single or double rows of openings along the sutures; well-developed subsutural canal and umbilical spiral canal system; umbilicus elevated with umbilical boss, which partly smooth, partly ornamented with pustules; wall optically radial; surface smooth and perforate except the umbilical region; aperture and foramina interiomarginal, single slit at base of septal face, and may also have multiple areal openings.

Remarks: The very peculiar ornamentation on the umbilicus of the studied specimens (partly ornamented with pustules, partly smooth) is very similar to the umbilicus ornamentation of *Nonion serenus* described by VENGLINSKI (1958), but it has more chambers than the Hungarian form.

Distribution: Early Sarmatian: Budapest (Hungary) (this study).

Family Elphidiidae GALLOWAY, 1933
Subfamily Elphidiinae GALLOWAY, 1933
Genus *Cribroelphidium* CUSHMAN et BRÖNNIMANN, 1948

Cribroelphidium ex. gr. *granosum* (D'ORBIGNY, 1846)
Pl. 3, Figs 3-4.

1846. *Nonionina granosa* n. sp. – D'ORBIGNY, p. 110, pl. 5, figs 19-20.

Material: About 100 specimens in the biofacies with *Elphidium*, about 850 specimens in the biofacies with *Cibicides* and about 100 in the biofacies with *Articulina* and *Nodophthalmidium*.

Dimensions: Diameter: 0.25-0.36 mm, thickness: 0.13-0.2 mm.

Description: Test circular, planispiral, involute; periphery rounded; eight to twelve slightly inflated chambers in the final whorl; sutures slightly depressed and curved; umbilicus wide and flat or more or less concave, with umbilical spiral canal system; ponticuli few and very indistinct; fossettes relatively broad; surface smooth and distinctly perforate except the umbilical and sutural regions, which are covered by numerous pustules; aperture multiple, interiomarginal, at the base of apertural face.

Variability: The ornamentation of the umbilical and sutural regions and the distinctness of the pores on the surface are very variable.

Remarks: We agree with the discussion of BRESTENSKÁ (1974) that the holotypes *Nonionina granosa* (D'ORBIGNY), *Nonionina perforata* (D'ORBIGNY), *Nonionina punctata* (D'ORBIGNY), *Nonionina subgranosa* (EGGER) and *Nonion martkobi* BOGDANOWICZ belong to the same group and they seem to be ecological variations. The umbilical region is very variable in this group.

Distribution: The group is widely distributed in the Paratethys from Miocene to recent. Most common in the Upper Sarmatian.

Genus *Elphidium* DE MONFORT, 1808

Elphidium aculeatum (D'ORBIGNY, 1846)
Pl. 3, Figs 5-6.

1846. *Polystomella josephina* n. sp. – D'ORBIGNY, p. 130, pl. 6, figs 25-26.
1846. *Polystomella aculeata* n. sp. – D'ORBIGNY, p. 131, pl. 6, figs 27-28.
1951. *Elphidium aculeatum* (D'ORBIGNY) – MARKS, p. 50, pl. 6, figs 11a,b.
1952. *Elphidium josephina* (ORBIGNY) – VOLOSHINOVA, p. 40, pl. 4, fig. 3.
1952. *Elphidium aculeatum* (ORBIGNY) – VOLOSHINOVA, p. 41, pl. 4, figs 2,4,5,6.
1958. *Elphidium josephinum* (D'ORBIGNY) – VENGLINSKI, p. 120, pl. 22, fig. 3.
1958. *Elphidium aculeatum* (D'ORBIGNY) – VENGLINSKI, p. 112, pl. 23, fig. 3.

1960. *Elphidium aculeatum* (ORBIGNY) – STANCHEVA, p. 18, pl. 3, fig. 2.
1960. *Elphidium josephinum* (ORBIGNY) – STANCHEVA, p. 19, pl. 3, fig. 8.
1963. *Elphidium aculeatum aculeatum* (D'ORBIGNY) – PAPP, p. 274, pl. 11, fig. 7.
1963. *Elphidium josephinum* (D'ORBIGNY) – PAPP, p. 274, pl. 11, fig. 6.
1964. *Elphidium aculeatum* (D'ORBIGNY) – KORECZ-LAKY, pl. 1, fig. 3.
1965. *Elphidium josephinum* (D'ORBIGNY) – KORECZ-LAKY, p. 355, pl. 1, fig. 6.
1968. *Elphidium aculeatum* (D'ORBIGNY) – KORECZ-LAKY, p. 90, pl. 1, fig. 11.
1970. *Elphidium aculeatum* (D'ORBIGNY) – DIDKOWSKI, SATANOVSKAJA, p. 114, pl. 70, fig. 1.
1970. *Elphidium josephina* (D'ORBIGNY) – DIDKOWSKI, SATANOVSKAJA, p. 120, pl. 71, fig. 7.
1971. *Elphidium josephinum* (D'ORBIGNY) – MOULINIER, pl. 2, fig. 5.
1973. *Elphidium josephinum* (D'ORBIGNY) – KORECZ-LAKY, pl. 4, fig. 1.
1973. *Elphidium aculeatum* (D'ORBIGNY) – KORECZ-LAKY, pl. 4, fig. 14.
1974. *Elphidium aculeatum* (ORBIGNY) – BRESTENSKÁ, p. 259, pl. 5, fig. 1.
1974. *Elphidium josephinum* (D'ORBIGNY) – BRESTENSKÁ, pp. 259-260, pl. 5, fig. 3.
1982. *Elphidium aculeatum* (D'ORBIGNY) – KORECZ-LAKY, pl. 1, figs 1-2.
1982. *Elphidium aculeatum* (D'ORBIGNY) – SZCZECHURA, pl. 14, fig. 8.
1982. *Elphidium josephinum* (D'ORBIGNY) – SZCZECHURA, pl. 15, fig. 1.
1985. *Elphidium aculeatum* (D'ORBIGNY) – PAPP, SCHMID, p. 52, pl. 43, figs 1-7.
1991. *Elphidium aculeatum* (D'ORBIGNY) – CIMERMAN, LANGER, p. 77, pl. 89, figs 1-4.
1992. *Elphidium aculeatum* (D'ORBIGNY) – GÖRÖG, pp. 115-116, pl. 11, figs 6-7.
1997. *Elphidium aculeatum* (ORBIGNY) – ZLINSKÁ, p. 291, pl. 1, fig. 6.
1998. *Elphidium josephinum* (D'ORBIGNY) – CICHA et al., p. 95, pl. 75, figs 11-13.
1998. *Elphidium aculeatum* (D'ORBIGNY) – CICHA et al., p. 95, pl. 75, figs 14-15.
2000. *Elphidium aculeatum* (D'ORBIGNY) – SZCZECHURA, pl. 5, fig. 2.
2001. *Elphidium aculeatum* (D'ORBIGNY) – KOVÁCS, pl. 7, figs 1-2.
2005. *Elphidium aculeatum* (D'ORBIGNY) – SUCIU, PL. 2, FIG.9.
2007. *Elphidium aculeatum* (D'ORBIGNY) – SCHÜTZ et al., p. 458, pl. 7, fig. 3.
2007. *Elphidium josephinum* (D'ORBIGNY) – SCHÜTZ et al., p. 459, pl. 7, fig. 7.
2007. *Elphidium aculeatum* (D'ORBIGNY)/*Elphidium josephinum* (D'ORBIGNY) (transitional form) – SCHÜTZ et al., pl. 7, fig. 8.

Material: About 70 specimens in the biofacies with *Elphidium*, about 3300 specimens in the biofacies with *Cibicides* and about 430 in the biofacies with *Articulina* and *Nodophthalmidium*.

Dimensions: Diameter: 0.45-0.60 mm, thickness: 0.2-0.35 mm.

Description: Test planispiral, involute, nearly circular in outline, flattened; periphery angled; twelve to seventeen chambers in the final whorl, the size of chambers slowly growing in the adult stage; sutures distinct, depressed; septa curved and terminating in spines; ponticuli elongate, eight to twelve on each chambers, fossettes narrow and granulated; umbilicus slightly depressed; wall optically radial, row of foramina at the base of septal face.

Variability: The size of spines is very variable. Probably this variability is controlled ecologically.

Remarks: We also accept the opinion of PAPP and SCHMID (1985) that *E. josephinum* (D'ORBIGNY, 1846) is the juvenile stage of *E. aculeatum*.

Distribution: Late Badenian to Sarmatian: Volhyno-Podolian platform, Moldavia, Precaucasus (Ukraine) (VENGLINSKI, 1958; DIDKOWSKI, SATANOVSKAJA, 1970), Crimea-Caucasus region, Apseron peninsula (VOLOSHINOVA, 1952); Sarmatian: Carpathian Foredeep (Poland) (SZCZECHURA, 1982, 2000), Vienna Basin (Austria) (MARKS, 1951; PAPP, 1963; PAPP, SCHMID, 1985; CICHA et al., 1998; SCHÜTZ et al., 2007), Danube Basin and East-Slovakian Basin (Slovakia) (BRESTENSKÁ, 1974; ZLINSKÁ, 1997), Tokaj Mts, East-Mecsek Mts, Zsámbék Basin, Budapest (Hungary) (KORECZ-LAKY, 1973, 1968, 1964, 1965, 1982; GÖRÖG, 1992; this study), Transylvanian Basin (KOVÁCS, 2001; SUCIU, 2005, NW-Bulgaria (Stancheva, 1960); Recent: Mediterranean (MOULINIER, 1971; CIMERMAN, LANGER, 1991).

The specimens of *Elphidium aculeatum* are the most common in the Lower Sarmatian beds of the Central Paratethys.

Elphidium crispum (LINNÉ, 1758)
Pl. 3, Figs 7-8.

1758. *Nautilus crispus* n. sp. – LINNAEUS, Systema Naturae, Holmiae, Suecia, 1, p. 709, pl. 1, figs 2d-e (fide Ellis and Messina Catalogue).
1798. *Nautilus crispus* LINNÉ – FICHTEL, MOLL, p. 40, pl. 5, figs a-b.
1846. *Polystomella crispa* D'ORBIGNY – D'ORBIGNY, p. 125, pl. 6, figs 9-14.
1952. *Elphidium crispum* (LINNÉ) – VOLOSHINOVA, pp. 42-43, pl. 4, fig. 12.
1958. *Elphidium crispum* (LINNÉ) – VENGLINSKI, p. 115, pl. 25, figs 2.
1959. *Elphidium crispum* (LINNEO) –DIECI, p. 56, pl. 4, fig. 29.
1962. *Elphidium crispum* (LINNE) – CHIERICI et al., p. 138, pl. 1, fig. 6.
1963. *Elphidium crispum* (LINNE) – PAPP, p. 264, pl. 7, fig. 2, pl. 8, figs 1-5, pl. 9, figs 1-2.
1964. *Elphidium crispum* (LINNE) – KORECZ-LAKY, pl. 1, fig. 1.
1966. *Elphidium crispum* (LINNE) – MOULINIER, p. 194, pl. 1, figs 1-2.
1968. *Elphidium crispum* (LINNE) – KORECZ-LAKY, p. 90, pl. 5, fig. 15.
1970. *Elphidium crispum* (LINNE) – DIDKOWSKI, SATANOVSKAJA, p. 116, pl. 71, fig. 1.

1982. *Elphidium crispum* (LINNE) – SZCZECHURA, pl. 14, fig. 9.
1984. *Elphidium crispum* (LINNE) – RÖGL, HANSEN, p. 37, pl. 8, fig. 7, textfig. 10.
1984. *Elphidium granulatum* (COSTA) – RÖGL, HANSEN, pp. 37-38, pl. 8, fig. 8, textfig. 10A.
1985. *Elphidium crispum* (LINNE) – PAPP, SCHMID, p. 50, pl. 40, figs 6-10.
1991. *Elphidium crispum* (LINNAEUS) – CIMERMAN, LANGER, pp. 77-78, pl. 90, figs 1-6.
1992. *Elphidium crispum* (LINNE) – GÖRÖG, pp. 116-117, pl. 11, figs 8-9.
1996. *Elphidium crispum* (LINNE) – FILIPESCU, pl. 3, fig. 8.
1998. *Elphidium crispum* (LINNE) – CICHA et al., p. 95, pl. 75, figs 16-17.
2000. *Elphidium crispum* (LINNE) – CAHUZAC, POIGNANT, fig. 8/16.

Material: About 100 specimens in the biofacies with *Elphidium*, about 300 specimens in the biofacies with *Cibicides* and about 100 in the biofacies with *Articulina* and *Nodophthalmidium*.

Dimensions: Diameter: 0.45-1.5 mm, thickness: 0.33 mm.

Description: Test large, planispiral, lenticular, rhombic in cross-section; periphery carinate; seventeen to seventy-five slender chambers in the final whorl, sutures distinct, depressed and curved; ponticuli elongated, seven to thirteen on each chambers, fossettes granulated; umbilicus elevated with massive umbilical pile, forming an umbilical plug that ornamented with small pits; wall optically radial, row of foramina at the base of septal face.

Variability: The degree of plug ornamentation is very variable.

Remarks: In our opinion the specimen described as *E. granulatum* (COSTA) by RÖGL and HANSEN (1984) belongs to the species *E. crispum* (LINNÉ) because it differs only in size from *E. granulatum*.

Distribution: Langhian: Aquitaine Basin (France) (CAHUZAC, POIGNANT, 2000); Karpatian to Badenian: East-Mecsek Mts (Hungary) (KORECZ-LAKY, 1968); Badenian: Vienna Basin (Austria) (PAPP, SCHMID, 1985; CICHA et al., 1998; PAPP, 1963), Italy (DIECI, 1959); Karpatian to Sarmatian: Transcharpatians, Volhyno-Podolian platform, Caucasus (Ukraine) (VENGLINSKI, 1958; DIDKOWSKI, SATANOVSKAJA, 1970); Sarmatian: Carpathian Foredeep (Poland) (SZCZECHURA, 1982); East-Mecsek Hill, Zsámbék Basin, Budapest (Hungary) (KORECZ-LAKY, 1964, 1968; GÖRÖG, 1992; this study); Pliocene: Toscana, Italy (FICHTEL, MOLL, 1798; RÖGL, HANSEN, 1984); Recent: Mediterranean (LINNÉ, 1758; MOULINIER, 1966; CHIERICI et al., 1962; RÖGL, HANSEN, 1984; CIMERMAN, LANGER, 1991).

Elphidium fichtelianum (D'ORBIGNY, 1846)
Pl. 3, Fig. 9.

1846. *Polystomella Fichtelliana* n. sp. – d'Orbigny, p. 125, pl. 6, figs 7-8.
1951. *Elphidium fichtelianum* (D'ORBIGNY) – MARKS, p. 52, pl. 6, figs 12a,b.
1958. *Elphidium fichtellianum* (D'ORBIGNY) – VENGLINSKI, p. 116, pl. 24, fig. 4.
1959. *Elphidium fichtellinaum* (D'ORBIGNY) –DIECI, p. 56, pl. 4, fig. 30.
1963. *Elphidium fichtelianum fichtelianum* (D'ORBIGNY) – PAPP, p. 268, pl. 11, figs 1-2.
1965. *Elphidium fichtellianum* (D'ORBIGNY) – KORECZ-LAKY, p. 354, pl. 1, fig. 4.
1970. *Elphidium fichtellianum* (D'ORBIGNY) – DIDKOWSKI, SATANOVSKAJA, p. 118, pl. 71, fig. 3.
1973. *Elphidium fichtellianum* (D'ORBIGNY) – KORECZ-LAKY, pl. 4, fig. 3.
1974. *Elphidium fichtelianum* (D'ORBIGNY) – BRESTENSKÁ, p. 260, pl. 6, fig. 2.
1982. *Elphidium fichtellianum* (D'ORBIGNY) – KORECZ-LAKY, pl. 7, figs 1-2.
1985. *Elphidium fichtelianum* (D'ORBIGNY) – PAPP, SCHMID, p. 50, pl. 40, figs 1-5.
1992. *Elphidium fichtelianum* (D'ORBIGNY) – GÖRÖG, pp. 118-119, pl. 11, fig. 10.
1998. *Elphidium fichtellianum* (D'ORBIGNY) – CICHA et al., p. 95, pl. 76, figs 1-3.
2000. *Elphidium fichtelianum* (D'ORBIGNY) – SZCZECHURA, pl. 1, fig. 7.

Material: About 250 specimens in the biofacies with *Elphidium*, about 200 specimens in the biofacies with *Cibicides*.

Dimensions: Diameter: 0.43-0.9 mm, thickness: 0.1-0.16 mm.

Description: Test planispiral, oval to circular, strongly compressed; periphery sharply angled, carinate; sixteen to eighteen narrow chambers in the final whorl, chambers gradually increase in size; sutures distinct, depressed and curved; ponticuli elongated, up to twelve on the last chambers; umbilicus slightly depressed without umbilical pile; wall finely perforate; surface finely granulated; aperture a low slit or a row of small pores at the base of apertural face.

Distribution: Badenian: Romania (FILIPESCU, 1996), Vienna Basin (Austria) (D'ORBIGNY, 1846; PAPP, 1963; PAPP, SCHMID, 1985), Slovakia (BRESTENSKÁ, 1974), Italy (DIECI, 1959); Badenian to Sarmatian: Transcarpathians, Volhyno-Podolian platform, Precarpathians (Ukraine), Moldavia (VENGLINSKI, 1958; DIDKOWSKI, SATANOVSKAJA, 1970), Vienna Basin (MARKS, 1951); Sarmatian: Carpathian Foredeep (Poland) (SZCZECHURA, 2000), Danube Basin (W-Slovakia) (BRESTENSKÁ, 1974), Tokaj Hill, Zsámbék Basin, SW- Hungary (KORECZ-LAKY, 1965, 1973, 1982; GÖRÖG, 1992, this study).

Widely distributed in the Paratethys, especially common in the Lower Sarmatian.

Elphidium hauerinum (D'ORBIGNY, 1846)
Pl. 3, Figs 10-12.

1846. *Polystomella Hauerina* n. sp. – D'ORBIGNY, p. 122, pl. 6, figs 5-10.

1846. *Polystomella Antonina* n. sp. – D'ORBIGNY, p. 128, pl. 6, figs 17-18.
1846. *Polystomella Listeri* n. sp. – D'ORBIGNY, p. 128, pl. 6, figs 19-22.
1952. *Elphidium hauerinum* (ORBIGNY) – VOLOSHINOVA, p. 42, pl. 4, figs 10,11.
1958. *Elphidium antoninum* (D'ORBIGNY) – VENGLINSKI, p. 114, pl. 25, fig. 3.
1958. *Elphidium hauerinum* (D'ORBIGNY) – VENGLINSKI, p. 118, pl. 26, fig. 3.
1960. *Elphidium hauerinum* (ORBIGNY) – STANCHEVA, p. 20, pl. 2, fig. 9.
1960. *Elphidium antoninum* (D'ORBIGNY) – STANCHEVA, p. 21, pl. 3, fig. 12.
1963. *Elphidium antoninum* (D'ORBIGNY) – PAPP, pp. 262-263, pl. 10, figs 3-5.
1963. *Elphidium hauerinum* (D'ORBIGNY) – PAPP, p. 263, pl. 10, fig. 6.
1963. *Elphidium listeri* (D'ORBIGNY) – PAPP, p. 273, pl. 12, fig. 9.
1964. *Elphidium hauerinum* (D'ORBIGNY) – KORECZ-LAKY, pl. 1, fig. 7.
1965. *Elphidium semistriatum* var. *sarmatica* (D'ORB.) – KORECZ-LAKY, pp. 355-356, pl. 1, fig. 1.
1973. *Elphidium semistriatum* var. *sarmatica* DIDKOVSZKIJ-GUDINA – KORECZ-LAKY, pl. 4, fig. 12.
1968. *Elphidium hauerinum* (d'ORBIGNY) – KORECZ-LAKY, p. 91, pl. 1, fig. 8.
1970. *Elphidium antonina* (D'ORBIGNY) – DIDKOWSKI, SATANOVSKAJA, p. 116, pl. 70, fig. 2.
1970. *Elphidium hauerinum* (D'ORBIGNY) – DIDKOWSKI, SATANOVSKAJA, p. 119, pl. 72, fig. 2.
1974. *Elphidium antoninum* (ORBIGNY) – BRESTENSKÁ, p. 262, pl. 7, fig. 1.
1974. *Elphidium hauerinum* (ORBIGNY) – BRESTENSKÁ, p. 262, pl. 7, fig. 2.
1974. *Elphidium mirandum* KRASHENINNIKOV – Brestenská, p. 261, pl. 5, fig. 5.
1982. *Elphidium hauerinum* (D'ORBIGNY) – KORECZ-LAKY, pl. 4, figs 1-2.
1982. *Elphidium hauerinum* (D'ORBIGNY) – SZCZECHURA, pl. 15, fig. 4.
1982. *Elphidium antoninum* (D'ORBIGNY) – SZCZECHURA, pl. 15, fig. 6.
1985. *Elphidium hauerinum* (D'ORBIGNY) – PAPP, SCHMID, p. 49, pl. 38, figs 1-5, p. 51, pl. 41, figs 5-10, pl. 42, figs 1-4.
1992. *Elphidium hauerinum* (D'ORBIGNY) – GÖRÖG, pp. 120-121, pl. 12, figs 1-5.
1996. *Elphidium hauerinum* (D'ORBIGNY) – FILIPESCU, pl. 5, fig. 8.
1997. *Elphidium hauerinum* (ORBIGNY) – ZLINSKÁ, p. 292, pl. 2, figs 1-2.
1998. *Elphidium hauerinum* (D'ORBIGNY) – CICHA et al., p. 95, pl. 76, figs 6-7.
2000. *Elphidium hauerinum* (D'ORBIGNY) – SZCZECHURA, pl. 5, figs 1,10.
2001. *Elphidium hauerinum* (D'ORBIGNY) – KOVACS, pl. 7, fig. 4.
2001. *Elphidium* sp. – KOVÁCS, pl. 7, fig. 5.
2001. *Elphidium* sp.4 – KOVÁCS, pl. 8, figs 3-4.
non 2004. *Elphidium hauerinum* (D'ORBIGNY) – CAHUZAC, POIGNANT, pl. 4, fig. 15.
2005. *Elphidium hauerinum* (D'ORBIGNY) – SUCIU, pl. 2, fig. 10.
2007. *Elphidium hauerinum* (D'ORBIGNY) – SCHÜTZ et al., p. 459, pl. 7, figs 5a-b.
2007. *Elphidium* ex. aff. *hauerinum* (D'ORBIGNY) – SCHÜTZ et al., p. 459, pl. 7, figs 6b-d.

Material: About 180 specimens in the biofacies with *Elphidium*, about 260 specimens in the biofacies with *Cibicides*.

Dimensions: Diameter: 0.24-0.43 mm, thickness: 0.1-0.15 mm.

Description: Test medium-size, nearly circular, biumbilicate, planispirally coiled, involute; periphery rounded; eight to thirteen inflated chambers in the final whorl; sutures distinct and depressed, slightly curved; ponticuli very broad and short, six to eight on each chamber; no central pillar; umbilicus flat or slightly depressed, often ornamented with pustules; wall finely perforate and shiny; multiple aperture at the base of septal face.

Variability: The degree of ornamentation (the number of pustules) of the umbilicus is strongly varied. The chambers are more or less inflated. Periphery varies from broadly rounded to subrounded. The outline varies oval, circular to slightly angular.

Remarks: Very variable. We accept the revision of PAPP and SCHMID (1985), that *E. antonium* (D'ORBIGNY, 1846) and *E. listeri* (D'ORBIGNY, 1846) are identical with *E. hauerinum*.

The form illustrated by CAHUZAC & POIGNANT (2004) differs from the holotype and the specimens described by the author in the more number of ponticuli. The ponticuli and fossettes are less broad at the above-mentioned specimens compared to the holotype.

Distribution: Badenian?: Vienna Basin (Austria) (D'ORBIGNY, 1846; PAPP, SCHMID, 1985); Badenian to Sarmatian: Transcarpathians, Precarpathians (Ukraine) (VENGLINSKI, 1958; DIDKOWSKI, SATANOVSKAJA, 1970); Sarmatian: N-Caucasus (VOLOSHINOVA, 1952), NW-Bulgaria (STANCHEVA, 1960), Romania (FILIPESCU, 1996), Transylvanian Basin (Romania) (KOVÁCS, 2001; SUCIU, 2005), Vienna Basin (Austria) (D'ORBIGNY, 1846; PAPP, SCHMID, 1985; PAPP, 1963; Schütz et al., 2007; CICHA et al., 1998), Tokaj Mts, Zsámbék Basin, East-Mecsek Mts, SW-Hungary, Budapest (KORECZ-LAKY, 1964, 1965, 1968, 1973, 1982; GÖRÖG, 1992; this study), Danube Basin and East-Slovakian Basin (Slovakia) (BRESTENSKÁ, 1974; ZLINSKÁ, 1997), Carpathian Foredeep (SZCZECHURA, 1982, 2000). The species are most common in the E. hauerinum Zone.

Elphidium macellum (FICHTEL et MOLL, 1798)
Pl. 3, Figs 13-15.

non 1798. *Nautilus macellus* n. sp. var. A – FICHTEL, MOLL, p. 66, pl. 10, figs e-g.
1798. *Nautilus macellus* n. sp. var. β – FICHTEL, MOLL, p. 68, pl. 10, figs h,i,k.
1798. *Nautilus strigilatus* n. sp. var. β – FICHTEL, MOLL, p. 50, pl. 5, figs f-g.

1984. *Elphidium macellum* (FICHTEL et MOLL) – RÖGL, HANSEN, p. 38, pl. 9, figs 3-4, textfig. 12, p. 50, pl. 14, figs 2, 5-6, pl. 15, figs 1-2, textfig. 18B.
1992. *Elphidium macellum* (FICHTEL et MOLL) – GÖRÖG, pp. 121-122, pl. 12, figs 6-8.
1952. *Elphidium macellum* var. *macellum* (FICHTEL et MOLL) – VOLOSHINOVA, pp. 121-122, pl. 5, figs 2-3.
1958. *Elphidium macellum* (FICHTEL et MOLL) – VENGLINSKI, p. 123, pl. 24, fig. 3, pl. 26, fig. 4.
1959. *Elphidium macellum* (FICHTEL et MOLL) – DIECI, p. 56, pl. 4, fig. 31.
1962. *Elphidium macellum* (FICHTEL et MOLL) – CHIERICI et al., p. 138, pl. 1, fig. 8.
1964. *Elphidium macellum* (FICHTEL et MOLL) – KORECZ-LAKY, pl. 1, fig. 5.
1964. *Elphidium macellum* var. *aculeatum* SILVESTRI – KORECZ-LAKY, pl. 1, fig. 4.
1966. *Elphidium macellum* (FICHTEL et MOLL) var. *aculeatum* – MOULINIER, p. 194, pl. 1, fig. 9.
1968. *Elphidium macellum* (FICHTEL et MOLL) – KORECZ-LAKY, p. 91, pl. 1, fig. 15, pl. 6, fig. 10.
1970. *Elphidium macellum* (FICHTEL et MOLL) – DIDKOWSKI, SATANOVSKAJA, p. 121, pl. 72, fig. 7.
1970. *Elphidium macellum converia* VENGLINSKI – DIDKOWSKI, SATANOVSKAJA, p. 122, pl. 72, fig. 6.
1973. *Elphidium macellum* var. *aculeatum* SILVESTRI – KORECZ-LAKY, pl. 4, fig. 13.
1974. *Elphidium macellum* (FICHTEL et MOLL) – RESTENSKÁ, p. 263, pl. 6, fig. 4.
1982. *Elphidium macellum* (FICHTEL et MOLL) – KORECZ-LAKY, pl. 1, figs 3-4.
1989. *Elphidium macellum* (FICHTEL and MOLL) – GUDINA, LEVTCHUK, p. 22, pl. 1, figs 1-3.
1991. *Elphidium macellum* (FICHTEL and MOLL) – CIMERMAN, LANGER, pp. 78-79, pl. 89, fig. 9.
1996. *Elphidium macellum* (FICHTEL and MOLL) – FILIPESCU, pl. 5, fig. 9.
1997. *Elphidium macellum* (FICTHEL et MOLL) – ZLINSKÁ, p. 293, pl. 2, figs 3-4.
1997. *Elphidium samueli* ZLINSKÁ – ZLINSKÁ, p. 293, pl. 2, figs 7-8.
2001. *Elphidium macellum* (FICTHEL et MOLL) – KOVÁCS, pl. 7, fig. 7.
2005. *Elphidium macellum* (FICTHEL & MOLL) – SUCIU, pl. 2, fig. 11.

Material: About 1750 specimens in the biofacies with *Elphidium*, about 5800 specimens in the biofacies with *Cibicides* and about 750 in the biofacies with *Articulina* and *Nodophthalmidium*.

Dimensions: Diameter: 0.32-0.9 mm, thickness: 0.18-0.3 mm.

Description: Test planispiral, involute, nearly circular, slightly flattened, lenticular; periphery sharply angled and keeled; twelve to sixteen rather indistinct chambers in the last whorl; sutures distinct, depressed and gently curved; ponticuli long, distinct, seven to nine on each chamber; fossettes granulated; umbilicus flat or slightly depressed, without umbilical plug and ornamentation; wall optically radial; multiple aperture, with small protruding lips at the base of septal face.

Variability: The distinctness of the keel is very variable. According to Rögl and Hansen (1984) the spinose keel at the older part of the last whorl of the specimens appears to be an unstable character related to ecology.

Remarks: We accept the revision of Rögl and Hansen (1984) that the holotype of *E. macellum* is *Nautilus macellus* var. β because *N. macellus* var. α has more chambers per whorl, a more compressed test shape, more ponticuli per chamber and multiple additional areal apertures.

Distribution: Karpatian to Sarmatian: Transcarpathians, Precarpathians, Volhyno-Podolian platform (Ukraine), Moldavia, Precaucasus, Caucasus (Russia) (VENGLINSKI, 1958; DIDKOWSKI, SATANOVSKAJA, 1970); Badenian: SW-Hungary (KORECZ-LAKY, 1982); Italy (DIECI, 1959), Late-Badenian to Sarmatian: Caucasus, Ukraine (VOLOSHINOVA, 1952); Sarmatian: Transylvanian Basin, Podeni (Romania) (KOVÁCS, 2001; FILIPESCU, 1996; SUCIU, 2005), East-Mecsek Mts, SW-Hungary, Tokaj Mts, Zsámbék Basin (KORECZ-LAKY, 1964, 1968, 1973, 1982; GÖRÖG, 1992), Danube Basin and East-Slovakian Basin (Slovakia) (BRESTENSKÁ, 1974; ZLINSKÁ, 1997); Pliocene: California (GUDINA, LEVTCHUK, 1989); Recent: Mediterranean (CIMERMAN, LANGER, 1991; CHIERICI et al., 1962; MOULINIER, 1966; FICHTEL, MOLL, 1798; Rögl, HANSEN, 1984). Eocene to Recent (BRESTENSKÁ, 1974), the most common in the Middle Sarmatian.

Elphidium obtusum (D'ORBIGNY, 1846)
Pl. 3, Fig. 16.

1846. *Polystomella obtusa* n. sp. – D'ORBIGNY, p. 124, pl. 6, figs 5-6.
1985. *Elphidium obtusum* (D'ORBIGNY) – PAPP, SCHMID, p. 50, pl. 39, figs 5-6.
1992. *Elphidium obtusum* (D'ORBIGNY) – GÖRÖG, pp. 122-123, pl. 12, figs 9-10.
?1960. *Elphidium obtusum* (D'ORBIGNY) – STANCHEVA, p. 21, pl. 3, fig. 10.
1963. *Elphidium obtusum* (D'ORBIGNY) – PAPP, p. 261, pl. 9, fig. 4.
2001. *Elphidium* sp.2 – KOVÁCS, pl. 7, fig. 6.

Material: About 20 specimens in the biofacies with *Cibicides* and about 24 in the biofacies with *Articulina* and *Nodophthalmidium*.

Dimensions: Diameter: 0.33-0.48 mm, thickness: 0.18-0.22 mm.

Description: Test planispiral, involute, lenticular; periphery subacute; twelve to fourteen chambers on the last whorl; sutures distinct and curved; ponticuli short and broad, six to eight on each chamber; umbilicus flat; no central pillar; wall finely perforate; surface smooth; multiple aperture at the base of septal face.

Remarks: Very similar to the *E. hauerinum*, but the studied specimens have more chambers that are not inflated, their umbilicus is flat and the periphery subrectangular. According to PAPP and SCHMID (1985) the indepenedent status of *E. obtusum* has not been well-grounded. The specimen illustrated by

STANCHEVA (1960) bears more ponticuli on each chamber than the holotype described by D'ORBIGNY (1846).

Distribution: Eggenburgian to Badenian: Vienna Basin (Austria) (PAPP, 1963); Eggenburgian to Sarmatian: Vienna Basin (Austria) (D'ORBIGNY, 1846; PAPP, SCHMID, 1985); Sarmatian: Zsámbék Basin, Budapest (Hungary) (GÖRÖG, 1992; this study); Transylvanian Basin (Romania) (KOVÁCS, 2001), NW-Bulgaria (STANCHEVA, 1960) (?).

Elphidium aff. *pulvereum* TODD, 1958
Pl. 3, Fig. 17.

1985. *Elphidium pulvereum* n. sp. – TODD, Foraminifera from western Mediterranean deep-sea cores. Swedish Deep-Sea Expedition 1947-48, Repts. 8/2/3, p. 201, pl. 1, figs 19-20 (fide Ellis and Messina Catalogue)

Material: Few specimens in the biofacies *Cibicides*.

Dimensions: Diameter: 0.62 mm, thickness: 0.16 mm.

Description: Test planispiral, nearly circular, strongly compressed; periphery carinate; fifteen rather indistinct chambers in the final whorl; sutures distinct, depressed and curved; ponticuli indistinct because of the surface granulosity, about seven on each chamber; umbilicus slightly depressed without umbilical pile; wall finely perforate; the entire surface strongly granulated; multiple aperture at the base of apertural face obscured by the surface granulosity.

Remarks: The studied specimens are very similar to the *El*

phidium pulvereum described by TODD (1958) because of the appearance of the granulosity on entire test surface. However the studied specimen has more chambers in the last whorl than the holotype described by TODD (1958). From the species *E. macellum* (FICHTEL et MOLL) the studied specimens differs in the surface granulosity. We can be not excluded that the specimens belong to the *E. macellum* group.

Distribution: Sarmatian: Budapest (Hungary) (this study).

Elphidium ex. gr. *puscharovski* SEROVA, 1955
Pl. 3, Fig. 19.

1970. *Elphidium puscharovski* SEROVA – DIDKOWSKI, SATANOVSKAJA, p. 123, pl. 74, fig. 4a-b. (holotype)

Material: Few specimens in the biofacies with *Cibicides*.

Dimensions: Diameter: 0.53 mm, thickness: 0.22 mm.

Description: Test planispiral, nearly circular, involute; periphery carinate; eleven very narrow chambers in the final whorl; sutures distinct, depressed and curved; ponticuli very elongate, six to seven on each chamber; umbilicus flat or slightly depressed; wall finely perforate; the surface finely granulated; multiple aperture at the base of septal face.

Remarks: The studied specimens are very similar to *E. puscharovski* SEROVA, 1955 (DIDKOWSKI, SATANOVSKAJA, 1970), only the chambers are narrower than those of the holotype.

Distribution: Sarmatian: Budapest (Hungary) (this study).

Elphidium reginum (D'ORBIGNY, 1846)
Pl. 3, Fig. 18.

1846. *Polystomella regina* n. sp. – D'ORBIGNY, p. 129, pl. 6, figs 23-24.
1985. *Elphidium reginum* (D'ORBIGNY) – PAPP, SCHMID, p. 52, pl. 42, figs 5-9, pl. 43, fig. 8.
1992. *Elphidium reginum* (D'ORBIGNY) – GÖRÖG, pp. 123-124, pl. 12, figs 11.
1952. *Elphidium regina* (ORBIGNY) – VOLOSHINOVA, p. 39, pl. 4, figs 7-9.
1932. *Elphidium regina* var. *caucasicum* – BOGDANOWICZ, FEDOROV, On some representatives of the genus Elphidium of the Sarmatian deposits of the lower Kuban River course. Trudy VNIGRI, ser. A, 22, p. 18, 49, pl. 1, figs 11-12, p. 18, textfigs 23-24, p. 19, textfigs 25-26 (fide Ellis and Messina).
1958. *Elphidium reginum* (D'ORBIGNY) – VENGLINSKI, p. 123, pl. 23, fig. 2.
1958. *Elphidium georgium* n. sp. – VENGLINSKI, p. 119, pl. 23, fig. 1.
1960. *Elphidium reginum* (ORBIGNY) – STANCHEVA, p. 20, pl. 3, fig. 7.
1963. *Elphidium reginum* (D'ORBIGNY) – PAPP, p. 275, pl. 11, fig. 8.
1964. *Elphidium reginum* (D'ORBIGNY) – KORECZ-LAKY, pl. 1, fig. 2.
1965. *Elphidium georgium* VENGLINSKI – KORECZ-LAKY, p. 354, pl. 1, fig. 5.
1968. *Elphidium imperatrix* (BRADY) – KORECZ-LAKY, p. 91, pl. 1, fig. 16.
1970. *Elphidium regina* (D'ORBIGNY) – DIDKOWSKI, SATANOVSKAJA, p. 124, pl. 74, fig. 6.
1970. *Elphidium regina caucasicum* BOGDANOWICZ – DIDKOWSKI, SATANOVSKAJA, p. 124, pl. 74, fig. 7.
1970. *Elphidium regina georgium* (VENGLINSKI) – DIDKOWSKI, SATANOVSKAJA, p. 124, pl. 74, fig. 8.
1973. *Elphidium reginum* (D'ORBIGNY) – KORECZ-LAKY, pl. 4, fig. 8.
1973. *Elphidium georgium* VENGLINSKI – KORECZ-LAKY, pl. 4, fig. 4.
1974. *Elphidium reginum* (ORBIGNY) – BRESTENSKÁ, p. 260, pl. 6, figs 3,5,6.
1982. *Elphidium imperatrix* (BRADY) – KORECZ-LAKY, pl. 2, figs 3-4, pl. 3, 1-4.
1982. *Elphidium reginum* (D'ORBIGNY) – SZCZECHURA, pl. 15, fig. 7-9.
1997. *Elphidium reginum* (ORBIGNY) – ZLINSKÁ, p. 293, pl. 2, figs 5-6.
1998. *Elphidium reginum* (D'ORBIGNY) – CICHA et al., p. 96, pl. 77, figs 5-7.
2005. *Elphidium reginum* (D'ORBIGNY) – SUCIU, pl. 2, fig. 12.
2007. *Elphidium reginum* (D'ORBIGNY) – SCHÜTZ et al., p. 459, pl. 8, fig. 4.

Material: More than 350 specimens in the biofacies with *Cibicides* and about 120 in the biofacies with *Articulina* and *Nodophthalmidium*.

Dimensions: Diameter: 0.63-0.98 mm, thickness: 0.1-0.2 mm.

Description: Test large, planispiral, nearly circular to irregular, involute; periphery acute; thirteen to seventeen indistinct, slightly inflated chambers in the final whorl; sutures distinct, depressed and curved; ponticuli elongate, eight to fifteen on each chamber; umbilicus flat or slightly depressed; a few, elongate spines on the edge; wall finely perforate; the surface finely granulated except the smooth spines; multiple aperture at the base of septal face.

Distribution: Late Badenian (?) to Lower Sarmatian: Volhyno-Podolian platform (Ukraine) (DIDKOWSKI, SATANOVSKAJA, 1970); Early Sarmatian: NW-Bulgaria (STANCHEVA, 1960), Transcarpathians, Kuban region (Ukraine), Moldavia (BOGDANOWICZ, FEDOROV, 1932; VENGLINSKI, 1958; Didkowski, SATANOVSKAJA, 1970), Transylvanian Basin (Romania) (SUCIU, 2005), Vienna Basin (Austria) (D'ORBIGNY, 1846; PAPP, SCHMID, 1985; PAPP, 1963; SCHÜTZ et al., 2007), Danube Basin, East-Slovakian Basin (Slovakia) (BRESTENSKÁ, 1974; ZLINSKÁ, 1997), East-Mecsek Mts, SW-Hungary, TOKAJ, Zsámbék Basin, Budapest (KORECZ-LAKY, 1964, 1965, 1968, 1973, 1982; GÖRÖG, 1992; this study), Carpathian Foredeep (Poland) (SZCZECHURA, 1982).

Remarks: The species is very special because of the few long spines on the periphery.

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Plate 1

(Scale bar: 100 μm)

Fig. 1. *Cycloforina contorta* (D'ORBIGNY, 1846). Front view. 618. borehole, depth 5,6 m.
Fig. 2. *Triloculina intermedia* KARRER, 1868. Front view. 618. borehole, depth 7,5 m.
Fig. 3. *Varidentella pseudocostata* (VENGLINSKI, 1958). Front view. 618. borehole, depth 7,5 m.
Fig. 4. *Articulina* sp. indet. Initial part broken. From the working pit in the Ludovika square, depth 1,8-3 m.
Figs 5, 5a. Miliolidea sp. Specimen covered by pits with teratogenic origin. 618. borehole, depth 5,3 m.
Fig. 6. Miliolidea sp. Specimen with irregular chamber arrangement. 618. borehole, depth 7 m.
Fig. 7-8. *Bolivina antiqua* D'ORBIGNY, 1846. Front view. From the ventillation tube of the Subway (line #3).
Figs 9, 10. *Bolivina moravica* CICHA et ZAPLETALOVÁ, 1961.
9. Front view. 596. borehole, depth 10,6-11,6 m.
10. Front view. 598. borehole, depth 13,2-14,5 m.
Figs 11, 13. *Bolivina moldavica* DIDKOWSKI, 1959. Front view. From the ventillation tube of the Subway (line #3).
Fig. 12. *Bolivina sarmatica* DIDKOWSKI, 1959. Front view. From the ventillation tube of the Subway (line #3).
Fig. 14. *Fursenkoina acuta* (D'ORBIGNY, 1846). Side view, opposite to the aperture. 596. borehole, depth 10,6-11,6 m.

Plate 1

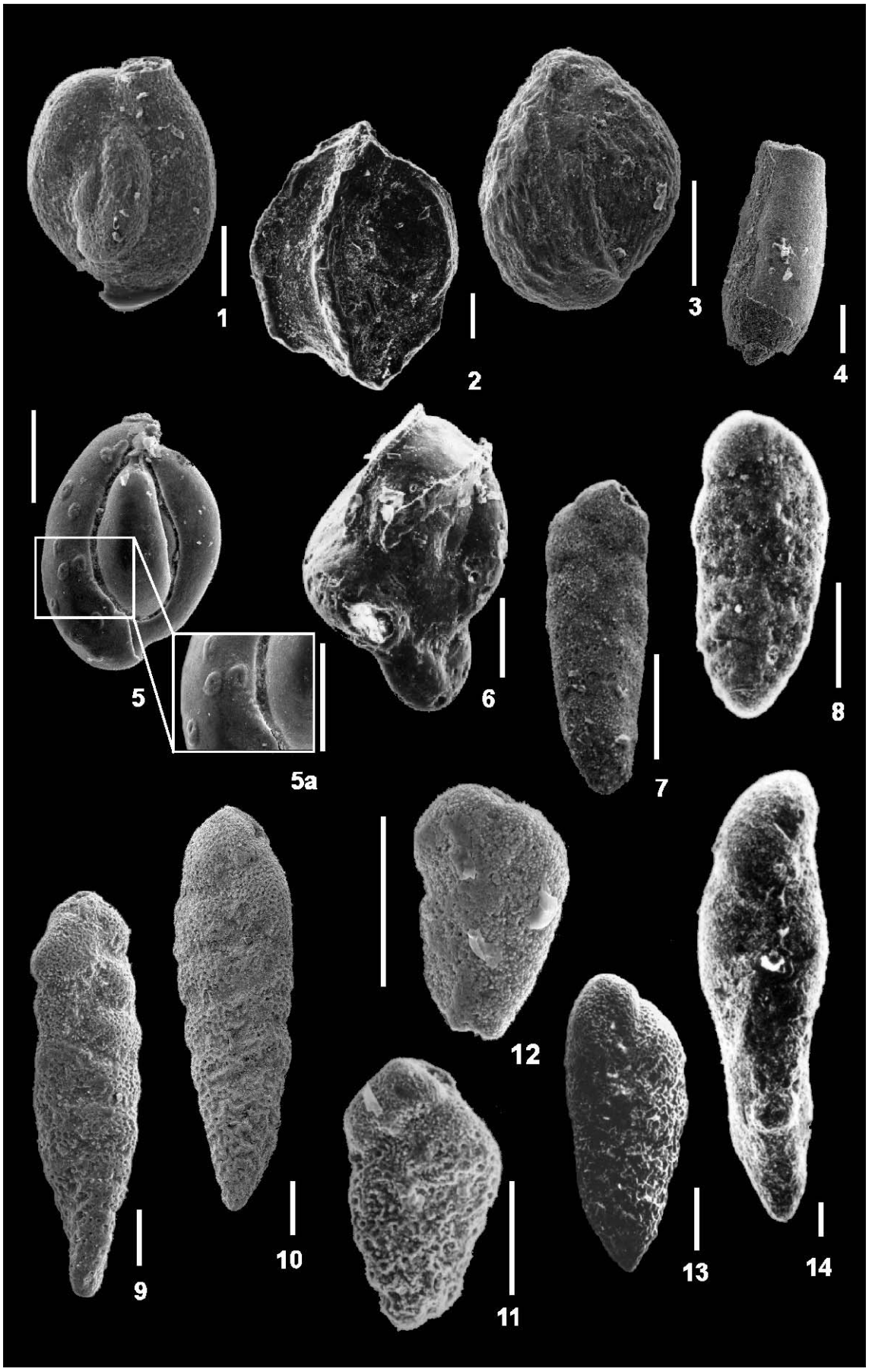

Plate 2

(Scale bar: 100 μm)

Fig. 1. *Fursenkoina sarmatica* (VENGLINSKI, 1958). Side view. 596. borehole, depth 10,6-11,6 m.

Figs 2-4. *Buliminella elegantissima* (D'ORBIGNY, 1839).
2-3. Side view with drop-shape aperture. From the ventillation tube of the Subway (line #3).
4. Side view, opposite to the aperture. From the ventillation tube of the Subway (line #3).

Fig. 5. *Caucasina schichkinskye* (SAMOYLOVA, 1947). Globular specimen, side view with the aperture. 596. borehole, depth 10,6-11,6 m.

Fig. 6. *Schackoinella imperatoria* (D'ORBIGNY, 1846). Dorsal side. From the working pit in the Ludovika square, depth 3-9 m.

Figs 7-8, 11-12. *Lobatula lobatula* (WALKER et JACOB, 1798).
7, 12. Ventral side. 598. borehole, depth 8,9-10,3 m.
8, 11. Dorsal side. 598. borehole, depth 8,9-10,3 m.

Figs 9, 13. *Nonion bogdanowiczi* VOLOSHINOVA, 1952.
9. Side view. 596. borehole, depth 14,5-17 m.
13. Side view with more inflated chambers. 596. borehole, depth 8-10,6 m.

Fig. 11. *Nonion commune*(?) (D'ORBIGNY, 1825). Side view. From the working pit in the Ludovika square, depth 9-10,8 m.

Figs 14-15. *Ammonia beccarii* (LINNÉ, 1758) forma parkinsoniana (D'ORBIGNY, 1839).
Fig. 14. Dorsal side. 618. borehole, depth 8,5 m.
Fig. 15. Ventral side with umbilical plug. 618. borehole, depth 8,5 m.

Fig. 16. *Ammonia beccarii* (LINNÉ, 1758). Specimen with irregular chamber arrangement. 598. borehole, depth 8,9-10,3 m.

Figs 17-18. *Ammonia beccarii* (LINNÉ, 1758).
18. Ventral side with short sutural fissures and umbilical plug. 598. borehole, depth 8,9-10,3 m.
19. Dorsal side. 598. borehole, depth 8,9-10,3 m.

Plate 2

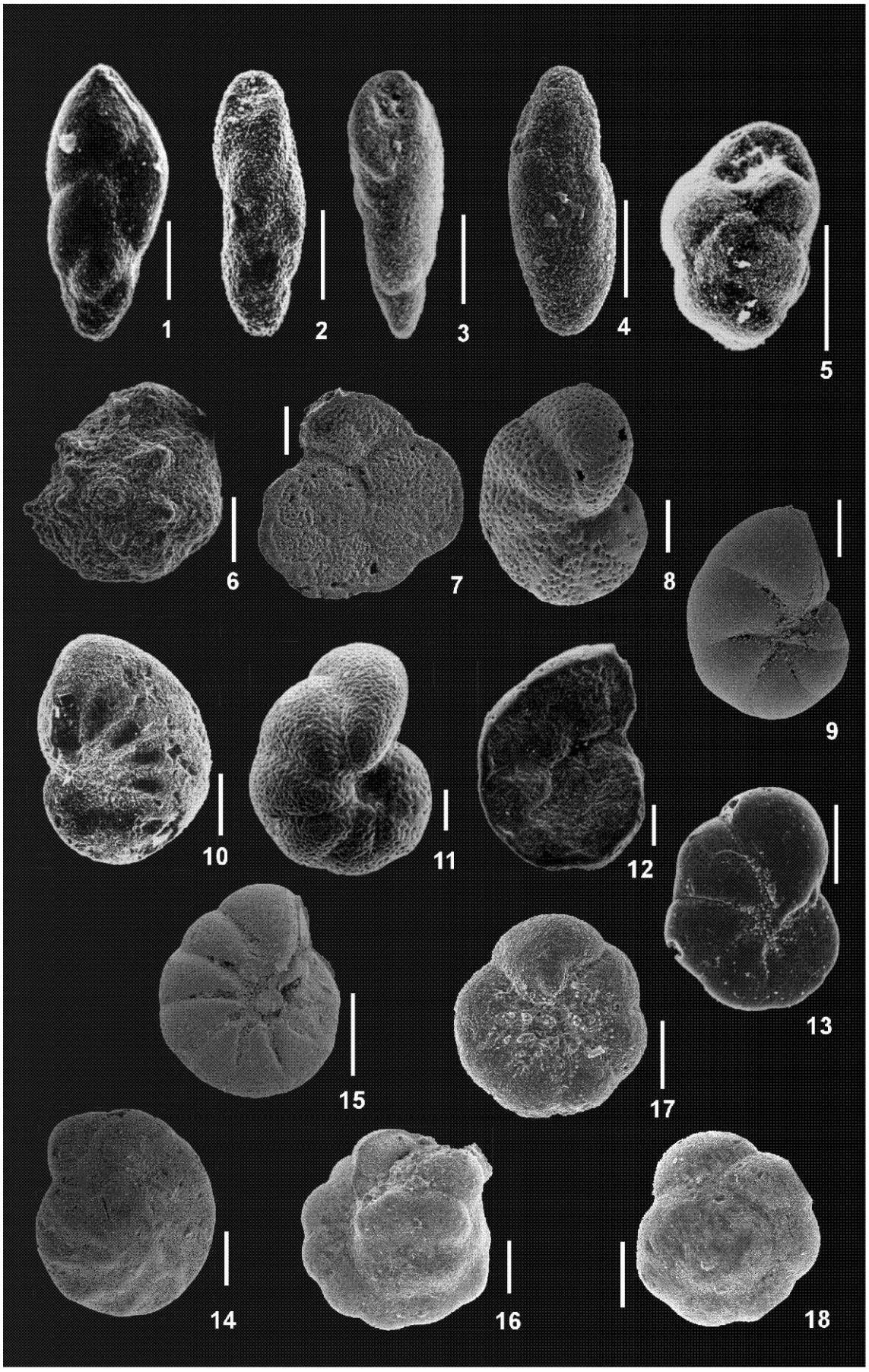

Plate 3

(Scale bar: 100 μm)

Figs 1, 2. *Elphidiella* aff. *serena* VENGLINSKI, 1958.
1. Side view. 596. borehole, depth 14,5-17 m.
2. Side view. 618. borehole, depth 8,5 m.

Figs 3, 4. *Cribroelphidium* ex. gr. *granosum* (D'ORBIGNY, 1846).
3. Side view. 618. borehole, depth 7 m.
4. Side view with numerous pustules in the sutural region. From the working pit in the Ludovika square, depth 9-10,8 m.

Figs 5, 6. *Elphidium aculeatum* (D'ORBIGNY, 1846).
5. Side view of an adult specimen. 598. borehole, depth 3-6 m.
6. Side view of an juvenile specimen („*E. josephinum* (D'ORBIGNY, 1846)"). 598. borehole, depth 19,7-22,6 m.

Figs 7, 8. *Elphidium crispum* (LINNÉ, 1758). From the working pit in the Ludovika square, depth 9-10,8 m.
7. Side view.
8. Side view of a large specimen with a prominent umbilical plug.

Fig. 9. *Elphidium fichtelianum* (D'ORBIGNY, 1846). Side view. 598. borehole, depth 10,3-13,6 m.

Figs 10-12. *Elphidium hauerinum* (D'ORBIGNY, 1846)
10. Side view of a specimen with pustules in the umbilical region. 598. borehole, depth 26,7-30 m.
11. Side view of a specimen with slightly angular shape. From the working pit in the Ludovika square, depth 9-10,8 m.
12. Apertural side. From the working pit in the Ludovika square, depth 9-10,8 m.

Figs 13-15. *Elphidium macellum* (FICHTEL & MOLL, 1798).
13. Side view. From the working pit in the Ludovika square, depth 9-10,8 m.
14. Side view of a specimen with a spinose keel at the older part of the last whorl. 618. borehole, depth 10,8 m.
15. Apertural view. From the working pit in the Ludovika square, depth 9-10,8 m.

Fig. 16. *Elphidium obtusum* (D'ORBIGNY, 1846). Side view. From the working pit in the Ludovika square, depth 9-10,8 m.

Fig. 17. *Elphidium* aff. *pulvereum* TODD, 1958. Side view. 596. borehole, depth 8-10,6 m.

Fig. 18. *Elphidium reginum* (D'ORBIGNY, 1846). Side view. From the working pit in the Ludovika square, depth 9-10,8 m.

Fig. 19. *Elphidium* ex. gr. *puscharovski* SEROVA, 1955. Side view. From the working pit in the Ludovika square, depth 9-10,8 m.

Plate 3